AMETEK®
POWER INSTRUMENTS

G20 ELECTRICITY METER USER MANUAL

AMETEK Power Instruments
255 North Union Street
Rochester, New York 14605

Tel: (800) 950-5503, (585) 263-7700
Fax: (585) 262-4777
Web: www.ametekpower.com

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Important Safety Notice

- Installation, operation, and maintenance of this product can present potentially hazardous conditions if safety procedures are not followed. To ensure that this product is used safely, it is important that you:
- Review, understand, and observe all safety notices and recommendations within this manual.
- Review your company safety procedures for meter installation and service.

DANGER

Hazardous voltages are present during normal servicing of this device that can cause severe injury or death. These voltages are present throughout the utility's potential transformer (PT) and current transformer (CT) circuits, and the meter's connection terminals. Only qualified, properly trained personnel should perform installation and servicing on this equipment.

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1. General Information

Ci20 Meter Overview

The *Ci20* Digital Power Meter is a multifunction electricity meter for use in revenue, survey, and control metering applications. *Ci20* is available in a variety of installation styles including Socket-base (S-base), and A-base using an adapter.

Ci20 incorporates features common to modern electronic polyphase meters including:

- Real and reactive power and energy measurement
- Industry standard packaging
- Display of consumption, demand, and *instantaneous* registers
- Load Profile data collection and storage
- Serial data communications options for remote retrieval of registers and Load Profile data, as well as programming
- Time of Use metering
- Pulse outputs

In addition, *Ci20* offers additional features and options not found in many existing meter products:

- Apparent power and energy
- Q measurements
- Per-phase voltage, current, and phase measurements
- Summation of energy measured by external devices (Totalization)
- Voltage and Current Transformer Gain Correction
- Field diagnostics
- Power quality monitoring
- Distortion measurement
- Thermal demand emulation
- Demand prediction
- Alarm outputs
- Wide voltage range (55 – 530 V)
- 2400 baud modem
- Call home on power outage or alarm conditions
- Contact Inputs
- Easy field-upgradeable meter firmware

NOTE

Certain features may require the installation of an optional module, firmware upgrade, or software package.

Supporting Software

The following packages are available for use with *Ci20*:

- *JEMWare Configuration* program for setting up the meter's operation. Also contained within *JEMWare* is a *Site Diagnostic Tool* which:
  - Displays the Site Monitor status
  - Displays the Site Diagnostic registers
  - Plots the real time readings in a graphical format
  - Plots real time readings on a polar graph
- *JEMRead Data Retrieval* program to:
  - Read and download data registers
  - Read and download Load Profile data
  - Read and download system Health and Status information
  - Read Event Logs
  - Set Time of Day and Date
  - Perform Billing Period Reset
- *UTS MV-90™ 1 Translation Interface Module (TIM)* software that can be added to an existing MV-90 system. This package performs the data retrieval functions that are normally assigned by *JEMRead*. For further information, contact AMETEK, or go to the web at www.itron.com.

Technical Description

Ci20 offers a large variety of meter register data that can be viewed from the meter's display or retrieved using serial communications. Some of the register types include consumption (summation), peak demand, time and date of peak demand, coincident demand, average power factor, coincident power factor, cumulative, continuous cumulative registers, and various status registers including date, time, health status, and firmware version. *Ci20* also has time-of-use capabilities, and most registers can be associated with a particular time-of-use rate.

The meter has an internal pulse recorder for storing load-profile data. The standard meter provides enough memory to store four channels of recorded data in 15 minute intervals for 64 days. Utilizing fewer channels extends the length of time data can be recorded, for example, reducing the number of channels by ½ doubles the length of recording time. Special events such as power failures, time sets, and demand resets are also stored in the load-profile data. This data can be retrieved through serial communications using *JEMRead*™ software. Optionally, a custom Translation Interface Module (TIM) is available for the popular MV-90™ software supplied by Itron, Inc. The *Ci20* meter can also provide contact outputs for external monitoring devices.

Serial communications are performed through an optical port on the front of the meter and a communication option board (RS-232, RS-485, internal modem, or ethernet). The meter has four levels of password protection with assignable privileges to accommodate read-only applications. A hardware *key* is also provided in the meter, which if removed prevents any configuration or calibration changes.

Ci20 is software configurable using *JEMWare*™. This software allows the meter to be scaled for direct primary readings, demand information, register information, load-profile configuration, and time-of-use rates. Refer to the *JEMWare* instruction manual 1083-602 for details on all the different parameters that can be programmed into the *Ci20*.

Event Recording

Ci20 maintains records of certain events independent of the Load Profile features. *JEMRead* is able to retrieve some of this information independently. However, if you need access to the data for troubleshooting or historical purposes, it is available in the meter. Contact AMETEK for information about using the Protocol Command Set Manual 1086-384.

All recorded events include the following information:

- A description of the type of event
- The date and time at which the event occurred
- If applicable, the time after the event

The following events are recorded:

Power Outage	Any recognizable failure of the auxiliary power is recorded with the time when power went down, the time at which it was restored, and an indication of which voltage inputs were live, as displayed on the potential indicators, when power went down. The five most recent power outages are saved in memory.
Time Set and Daylight Saving Time Change	These are recorded in the same list. They include the time before the change, the time after the change, and an indication of whether it was a manual (front panel or serial data) or automatic (Daylight Saving Time) change. The five most recent time changes are recorded.
Register Freeze	Each Freeze includes the time the Freeze was performed, as well as an indication of whether the Freeze was manual (serial command) or automatic. The five most recent Freezes are recorded.
Register Preset	The most recent Register Preset is recorded with the time at which the Preset occurred.
Test Mode	The most recent Test Mode session is recorded with the time at which the Test Mode session was entered and left.
Calibration	The most recent Calibration session is recorded with the time at which the Calibration occurred.
Site Monitoring	The 20 most recent Site Monitoring events are recorded. Each one includes the time at which the condition was detected as well as an indication of the detected condition.
Billing Period Reset	The five most recent Billing Period Reset events are recorded. Each one includes the time at which the reset was performed and an indication of whether the reset was automatic, a serial command, or a front-panel reset.

Configuration	The three most recent Configuration events are recorded. Each one includes the time at which the configuration occurred as well as an indication of whether it was a front-panel or remote (serial) configuration.
Voltage Sag / Swell	The 100 most recent voltage sags or swells detected by the meter are logged. Each event records the minimum, maximum, and average voltage and current and the average power factor for the duration of the event.

NOTE

Some events, such a power outages and freezes, are reported in the *JEMRead* Load Profile download.

Model Number Description

This user manual is applicable to a broad range of *Ci20* meter options. To determine the options on your meter, read the model number located in the center front of the meter faceplate and compare it to Table 1.1.

Table 1.1 Ci20 Model Number

Ci20 Base Meter					Base Options	
Meter Form	**Enclosure**	**Frequency**	**Display**	**Current**	**Communication Options**	**I/O Options**
• 05 = Form 5 • 06 = Form 6 • 08 = Form 8 • 09 = Form 9 • 26 = Form 26 • 35 = Form 35	• S = S Base • A = A Base	• 5 = 50 Hz • 6 = 60 Hz	• 0 = Std. LCD	• 20 = Class 20	• 0 = None • 1 = Single RS-232/485 • 2 = Dual RS-232/485 • 3 = 2400 Baud Modem • 4 = Modem w/PHPF • 5 = Modem & RS-232/485 • 6= Modem & RS-232/485 & PHPF • 7 = Ethernet • 8 = Ethernet & RS-232/485 *Choose one item above* *PHPF = Phone Home on Power Fail*	• 0 = None • 1 = 6 I/O • 2 = 6 I/O wiring wetted inputs *Choose one item above*

Table 1.2 Ci20 Additional Options

Additional Options	
• AT = Alarm Thresholds • TOT = Totalization • PQ = Power Quality • DP = Demand Prediction • MOD = Modbus Protocol • DNP = DNP Protocol • ANSI = ANSI Table Protocol	• 0 = No Additional Options • TOU = Time of Use • LP = 12 Channels Load Profile • 15 = 15 Additional Registers • 35 = 35 Additional Registers • PP= Per Phase Measurements • SM = Site Monitoring

Table 1.3 gives a typical example.

A typical model number would be:

Ci20-09S6020-81-TOU-LP-35-PP-SM-AT-TOT-PQ-DP-MOD

Table 1.3 Typical Model Number Example

Ci20	Ci20 Meter
09	Form 9
S	Socket Base
6	60 Hz
0	Standard LCD Display
20	Current Class 20
8	Ethernet & RS-232/485
1	6 I/O
TOU	Time of Use
LP	12 Channel Load Profile
35	Additional 35 Storage Registers
PP	Per Phase Measurements
SM	Site Monitoring
AT	Alarm Thresholds
TOT	Totalization
PQ	Power Quality
DP	Demand Prediction
MOD	Modbus Protocol

Ci20 Specifications

Product specifications are subject to change. Please consult the factory for updates, improvements, and new features.

Table 1.4 lists the meter forms.

Table 1.4 Meter Forms

Form Number	Type
Form 5, 26, 35	3 wire wye & delta, network
Form 6	2-1/2 element wye
Form 8	4 wire delta
Form 9	4 wire wye

Current classes include:

- 20 Amp (.01 – 20A)

Measured Quantities

Integrated Quantities

Integrated quantities are power measurement quantities that are integrated over time, and which may be accumulated. Integrated quantities are used for developing Consumption, Fixed or Sliding Window Demand (Peak or Coincident), Load Profile, or Pulse Contact outputs.

Ci20 measures the following integrated quantities:

- Watthours delivered/received, per-phase, polyphase total
- VARhours delivered/received, per-phase, polyphase total
- VAhours delivered/received, per-phase, polyphase total
- Amphours, per-phase (up to 3 phases), polyphase total
- Qhours delivered/received, per-phase, polyphase total
- V^2 hours, A^2 hours per-phase, polyphase total

Instantaneous Quantities

Instantaneous quantities are short-term average or RMS measurements of electrical characteristics in a circuit. Instantaneous quantities are suitable for Instantaneous Registers, or Thermal Demands.

Ci20 measures the following instantaneous quantities:

- Watts and VARs delivered, received, or bidirectional per-phase, polyphase
- VA delivered, received, or bidirectional per-phase, polyphase
- Q delivered, received, or bidirectional per-phase, polyphase
- Volts and Volts^2 per-phase (up to 3 phases)
- System Volts (average of 2 or 3 phases depending on meter form)
- Amps per-phase, polyphase plus Neutral Current
- Amps^2 per-phase, polyphase
- PF per-phase, polyphase
- Frequency
- Volts THD per-phase
- Amps THD per-phase

Figure 1.1 lists the Ci20 meter measurement available by type.

Ci20 Meter Measurements

Energy	Poly Phase		A Phase		B Phase		C Phase		4 quadrant	PolyPhase	A Phase	B Phase	C Phase	Average
	Del	Recv	Del	Recv	Del	Recv	Del	Recv	Poly, A,B,C	Total	Total	Total	Total	Total
Whr	B	B	PP	PP	PP	PP	PP	PP						
VARhr	B	B	PP	PP	PP	PP	PP	PP	B					
VAhr	B	B	PP	PP	PP	PP	PP	PP						
Qhr	B	B	PP	PP	PP	PP	PP	PP						
AMPhr										B	PP	PP	PP	B
AMP^2hr										B	PP	PP	PP	B
$VOLT^2hr$										B	PP	PP	PP	

Instantaneous & Demand	Poly Phase			A Phase			B Phase			C Phase			4 quadrant	Average	Neutral
	Del	Recv	Bi-Dir	Del	Recv	Bi-Dir	Del	Recv	Bi-Dir	Del	Recv	Bi-Dir	Poly, A,B,C	Bi-Dir	Bi-Dir
Watt	B	B	B	PP	PP	PP	PP	PP	PP	PP	PP	PP			
VAR	B	B	B	PP	PP	PP	PP	PP	PP	PP	PP	PP	B		
VA	B	B	B	PP	PP	PP	PP	PP	PP	PP	PP	PP			
Q	B	B	B	PP	PP	PP	PP	PP	PP	PP	PP	PP			
PF	B	B	B	PP	PP	PP	PP	PP	PP	PP	PP	PP			
VOLT			B			PP			PP			PP			
$VOLT^2$			B			PP			PP			PP			
AMP			B			PP			PP			PP		B	B
AMP^2			B			PP			PP			PP		B	B
Freq						PQ									
V_{THD}			PQ			PQ			PQ						
AMP_{THD}			PQ			PQ			PQ						

B = included in Base Meter *
PP = included in Per Phase Measurement Option *
PQ = included in Power Quality Option *

* *# of measurements dependent upon number of registers purchased. 15 Registers (measurements) included in base meter. Can be upgraded by 15 or 35 for total of 50 measurements.*

Figure 1.1 Ci20 Meter Measurements

Optional Features

Ci20 can be equipped with the following optional firmware features:

- Per phase measurements
- Additional 15 or 35 display registers (15 included in base meter)
- Time of Use
- Site Monitoring
- Alarm Thresholds
- Totalization
- Additional eight channels of Load Profile (four channels included as standard)
- Demand Prediction
- External Energy Totalization
- Voltage Sag / Swell detection and logging
- Modbus, DNP and ANSI Tables communications protocols

Input Range Limits and Burdens

Current Inputs

Table 1.5 lists the current inputs.

Table 1.5 Current Inputs

Current Input Class	Operation Range	Overload I_{max}	Burden at T_A S-, A-Base
Class 20	.01–20 A	40 A	0.5 VA

Voltage Inputs

Table 1.6 lists the voltage inputs.

Table 1.6 Voltage Inputs

Input	Value
$V_{nominal}$	69,120, 240, 277, 380, 480
V_{range}	55-530
Burden*	0.5 VA @ 530V

*Does not include auxiliary power requirements.

Current Overload

2x rated class current continuous 20x rated class current for one half second

Auxiliary Power

Table 1.7 Auxiliary Power

Input	Value
$V_{nominal}$	69,120, 240, 277, 380, 480
V_{range}	55-530

Auxiliary Power Burden

15 VA maximum, 10 VA typical (derived from the 3-phase voltage inputs)

Accuracy

The nominal conditions referenced in the specifications are defined as follows:

- V_{INPUT} = Nominal Input Voltage
- T_A = Test Amperes = ½ Class Amps
- I_{CLASS} = Meter Class Current
- Full Scale = I_{CLASS} x V_{INPUT}

Table 1.8 and Table 1.9 on page 1-14 lists the accuracy by class.

Table 1.8 Class 20

Watthours (per phase, polyphase total)	**Class 20 Input Current**	**Accuracy (PF=1)**	**Accuracy (PF=0.5 lag)**
	5.0 to 20 A	0.15 % RD	0.3 % RD
	0.5 to 5 A	0.15 % RD	0.5 % RD
	0.3 to 0.5 A	0.15 % RD	1.0 % RD
	0.1 to 0.3 A	0.30 % RD	1.0 % RD
VARhours (per phase, polyphase total)	**Class 20 Input Current**	**Accuracy (PF=0)**	**Accuracy (PF=0.5 lag)**
	5 to 20 A	0.2 % RD	0.3 % RD
	0.5 to 5 A	0.2 % RD	0.5 % RD
	0.3 to 0.5 A	0.2 % RD	1.0 % RD
	0.1 to 0.3 A	0.3 % RD	1.0 % RD
VAhours, Qhours (per phase, polyphase total)	**Class 20 Input Current**	**Accuracy (PF=1)**	**Accuracy (PF=0.5 lag)**
	5 to 20 A	0.2 % RD	0.3 % RD
	0.5 to 5 A	0.2 % RD	0.5 % RD
	0.3 to 0.5 A	0.2 % RD	1.0 % RD
	0.1 to 0.3 A	0.3 % RD	1.0 % RD

Instantaneous Watts (per phase, polyphase total)	**Class 20 Input Current**	**Accuracy (PF=1)**	**Accuracy (PF=0.5 lag)**
	5 to 20 A	0.20 % RD	0.35 % RD
	0.5 to 5 A	0.20 % RD	0.5 % RD
	0.3 to 0.5 A	0.20 % RD	1.0 % RD
	0.1 to 0.3 A	0.35 % RD	1.0 % RD

Table 1.8 Class 20 (Continued)

Instantaneous Vars (per phase, polyphase total)	**Class 20 Input Current**	**Accuracy (PF=0)**	**Accuracy (PF=0.5 lag)**
	5 to 20 A	0.25 % RD	0.35 % RD
	0.5 to 5 A	0.25 % RD	0.5 % RD
	0.3 to 0.5 A	0.25 % RD	1.0 % RD
	0.1 to 0.3 A	0.35 % RD	1.0 % RD
Instantaneous VA, Q (per phase, polyphase total)	**Class 20 Input Current**	**Accuracy (PF=1)**	**Accuracy (PF=0.5 lag)**
	5 to 20 A	0.25 % RD	0.35 % RD
	0.5 to 5 A	0.25 % RD	0.5 % RD
	0.3 to 0.5 A	0.25 % RD	1.0 % RD
	0.1 to 0.3 A	0.35 % RD	1.0 % RD

Table 1.9 Class 20

Instantaneous Volts (per phase, polyphase total)	**Range**	**Accuracy**
	55 - 530 VAC	0.15 % RD
Instantaneous Amps (per phase, polyphase total)	.1 - 20 A	0.15 % RD + 0.025 % Iclass
Instantaneous Volts^2 (per phase)	55 - 530 VAC	0.2 % RD
Instantaneous Amps^2 (per phase, polyphase total)	.1 - 20 A	0.2 % RD + 0.005 % Iclass^2
Volts^2 Hours (per phase)	55 - 530 VAC	0.2 % RD
Amphours (per phase, polyphase total)	**Input Current**	**Accuracy**
	1to 20 A	0.3 % RD
	0.5 to 1 A	0.6 % RD

Table 1.9 Class 20 (Continued)

Amp^{2}Hours (per phase, polyphase total)	2 A to 20 A	0.3 % R
	1 to 2 A	1.0 % RD
	0.5 to 1 A	3.0 % RD
Measured Quantity (All)		
Instantaneous Power Factor (per phase)	0.004 * FS / VAphase	
Instantaneous Power Factor (system)		
Form 5	0.004 * 2FS / VAsystem	
Form 6, 8/9	0.004 * 3FS / VAsystem	
Volts THD	1.0 % absolute	
Amps THD	1.0 % absolute	
Frequency (phase A Volts)	0.03 % RD	

Auxiliary Power

Requirements 55 – 530 Volts AC

Source S-base and A-base: derived from 3-phase power

Auxiliary Power Burden

15 VA maximum; 10 VA typical

Temperature Operating Ranges

External Environment - 30° C to +85° C

Storage Temperature - 40° C to +85° C

Frequency Range

50 Hz	45 to 55 Hz
60 Hz	55 to 65 Hz

Clock Accuracy

External tracking (line frequency)

Accuracy of the clock is directly determined by the power system frequency, except during loss of auxiliary power to the meter. The internal reference accuracy is applicable for that time period.

Internal tracking: Three minutes per month maximum error (crystal referenced)

Meter Creep

The meter does not creep

No pulses or registration occurs on any function that depends on current with the current circuit open.

Contact Inputs/Outputs (Option)

Six channels are jumper configurable as input or output.

Pulse/Contact Alarm Outputs

Pulse Outputs based on

Watthours, VARhours, VAhours, Qhours, Amphours, V^2 hours, A^2 hours

Alarm Outputs based on

Watts, VARs, VA, Q, Amps, $Amps^2$, Volts, $Volts^2$, PF, THD, and Frequency

Type: *KYZ* - Three-wire, dry Form-C, solid-state switching FET, requires external wetting voltage; configurable via *JEMWare* software.

Max. open-circuit voltage

200V DC or peak AC

Max. closed-circuit Saturation voltage drop

2.5 V at 30 mA max

Max. rated switching current

50 mA

TTL-compatible output

External 4.7 kOhm pull-up to +5Vdc

	Usage	User-configurable to monitor: • Any consumption quantity • Energy pulse constant (KYZ mimic) • Site Monitor alarm • Threshold alarm • Demand Sync • Voltage Sag / Swell alarm • System Error alarm
	Max. Rate of Operation	20 transitions per second For example, 10 full close/open pulse cycles per second
Contact Inputs	Type	Two-wire, Form-A contact inputs, wetted or non-wetted, jumper configurable
	Minimum ON Voltage	10 VDC
	Maximum ON Voltage	40 VDC
	Maximum Input Current	50 mA
	Maximum Pulse Rate	10 transitions per second
	Usage	User-configurable for: • Pulse counter • Interval Synchronization Pulse • TOU Rate Override • Status input • Totalization input
	Internal Wetting Voltage	12 VDC

Test Outputs

	Type	IR LEDs test outputs are provided through the optical port transmitter, which becomes a test output when the meter is in the test mode.

Registers

Instantaneous Registers	Characteristics	Include: • Updated every 1.5 seconds • Average of 1.5 seconds
	Displayed Quantities	
	Per Phase and Polyphase	W Del, W Rec,, W Bidirectional, VAR Del, VAR Rec, VAR Q1, VAR Q2, VAR Q3, VAR Q4, VAR Bidirectional, VA Del, VA Rec, VA Bidirectional, Volts, Amps, Q Del, Q Rec, Q Bidirectional, PF Del, PF Rec, PF Bidirectional, V^2, A^2
	Per Phase	Volts THD, Amps THD
	Phase A only	Frequency
Consumption Registers	Characteristics	Include: • Updated no less than every two seconds • Configurable to be associated with any Time of Use (TOU) Rate. If associated with any rate other than Total, the Consumption Register shall accumulate only energy measured while that rate is active
	Displayed Quantities	Per Phase and Polyphase Wh Del, Wh Rec, VARh Del, VARh Rec, VAh Del, VAh Rec, VARh per quadrant, Ah, Qh Del, Qh Rec, V^2h, A^2h
	Display scaling	In secondary (at meter terminals) or primary (at PT / CT input) units
	Preset	Any desired value that may be displayed
	Register Retrieval	By serial communications

Totalization Registers (optional)	Characteristics	Include: • Special-purpose Consumption registers • Displayed quantities, scaling, preset, and register retrieval are identical to Consumption registers. • Can be configured to add additional accumulation in response to energy pulses received on the *Ci20*'s Contact Input channels. See the *JEMWare* User Manual (document 1083-602) for details on setting up Totalization registers.
Average Power Factor Registers	Characteristics	Configurable to be associated with any Time of Use (TOU) Rate. If associated with any rate other than Total, the Average PF Register is based only on energy accumulated while that rate is active. Average Power Factor is available only as a register.
	Display	Average Power Factor (PF) for the Billing Period.
	Calculation	The PF is calculated continuously from Watts and VAs accumulated since the last Billing Period Reset. The accumulators are cleared on a Billing Period Reset.
Demand (Fixed or Sliding Window) Registers	Displayed Quantities	Per Phase and Polyphase W Del, W Rec, VAR Del, VAR Rec, VA Del, VA Rec, VAR per quadrant, A, Q Del, Q Rec
	Display scaling	In secondary (at meter terminals) or primary (at PT / CT input) units.
	Demand Interval Length	1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30, or 60 minutes Configurable for one or more subintervals per interval, as long as the total interval length (number of subintervals per interval times subinterval length) equals one of the periods listed above. No more than 12 subintervals per interval.
	Preset	Any desired value that can be displayed
	Register Retrieval	By serial communications

Peak Demand	Displayed Quantities	
		Normal peak, Cumulative Demand, or Continuous Cumulative Demand
	Characteristics	Configurable to be associated with any Time of Use (TOU) Rate. If associated with any rate other than Total, the Peak Demand Register is calculated only on energy measured while that rate is active.
Time of Peak Demand	Displayed Quantities	
		Time or Date at which the corresponding Peak Demand occurred
Coincident Demand	Displayed Quantities	
	Per Phase and Polyphase	
		W Del, W Rec, VAR Del, VAR Rec, VA Del, VA Rec, VAR per quadrant, A, Q Del, Q Rec
	Display scaling	In secondary (at meter terminals) or primary (at PT / CT input) units.
	Demand Interval Length	
		Matches the corresponding Peak Demand length
	Preset	Any desired value that may be displayed
	Register Retrieval	By serial communications
Coincident Power Factor	Displayed Quantities	
		Average PF over the Demand Interval in which a Peak Demand was established
Thermal Demand Registers	Types	Include: • Thermal Demand • Peak Thermal Demand • Time of Peak Thermal Demand
	Displayed Quantities	
	Per Phase and Polyphase	
		W Del, W Rec, VAR Del, VAR Rec, VA Del, VA Rec, VAR per quadrant, Volts, A, Q Del, Q Rec, PF
	Per Phase	Volts THD, Amps THD
	Phase A only	Frequency

Demand Prediction Registers (optional)	Displayed Quantities	Per Phase and PolyphaseW Del, W Rec, VAR Del, VAR Rec, VA Del, VA Rec, VAR per quadrant, Amp, Q Del, Q Rec
Status Registers	Storage	Time, date, firmware version, comm setting, and health status
Time of Use Registers	Description	Features include: • Four season schedules • Nine day types including each day of the week and two holiday types • Twenty-year calendar with up to 200 holidays specified • Each measurement register can be associated with one of nine time-of-use rates (A – H, and Total) • Up to eight rate changes can be specified for each day type
Load Profile	Displayed Quantities Per Phase and Polyphase	Wh Del, Wh Rec, VARh Del, VARh Rec, VAh Del, VAh Rec, VARh per quadrant, Ah, Qh Del, Qh Rec, Avg. W Del, Avg. W Rec, Avg. VAR Del, Avg. VAR Rec, Avg. VAR per quadrant
	Description	Features include: • Up to 12 channels of storage (four standard) • Programmable interval length (1, 2, 3, 4, 5, 6, 10, 12, 15, 30, and 60 minutes); independent of Demand Interval • Can record optional Totalization channels as well. See Totalization registers above.

Communication Ports

Optical Port

Features include:

- Type 2, Front panel mounted
- Mating Sensor can be attached with the meter cover installed (magnetic type), or cover removed (hanging type)
- Complies with ANSI C12.13-1991, Section 3.6
- Configurable for all Ci20 Protocol
- User configurable for 300 to 19200 baud

Single Serial Port Option

User configurable for RS-232 or RS-485.

RS-232

Features include:

- Supports Tx, Rx, Gnd, and RTS signals
- Configurable for 300 to 38400 baud
- Mutually exclusive with RS-485 option
- Configurable for all *Ci20* protocols

RS-485

Features include:

- Supports Tx, Rx, Gnd signals
- Half duplex operation
- Configurable for 300 to 38400 baud
- Mutually exclusive with RS-232 option
- Configurable for all *Ci20* protocols
- Recommended max. cable length: 4000'; actual length is dependent upon environment

Dual Serial Port Option

Features include:

- Two independent serial ports
- User-configurable for RS-232 or RS-485

Internal Modem Option

Features include:

- Configurable for 2400 baud only
- Configurable answer schedule
- Configurable for All Ci20 protocol

Compliance — Includes:

- CCITT: V.34 bis, V.34, V.32 bis, V.32, V.22 bis,V.22, and V.21
- Bell®: 212A and 103

Speeds — Includes:

- 2400, 1200, and 300 bps
- Industry Standard *AT* command set
- V.42/MNP® protocols (Error correction: V.42, MNP® 2-4, and MNP 10)

Data Compression — V.42 bis and MNP 5

Call-Home on Power Outage Modem Option

Features include:

- Internal modem that calls up to four telephone numbers and transmits a message during power failure
- User configurable phone numbers and messages

Ethernet Option

Features include:

- 10 Base-T physical layer; RJ45 connector
- Up to four simultaneous connections
- Supports all available serial protocols:
  - Modbus RTU, ASCII slave mode
  - DNP 3.0
  - ANSI Tables
  - JEM Binary

Environmental

Specification	Operable in weather, rain, and salt-spray environments as specified in ANSI Standard C12.20.
Operating Temperature Range	-30° to +85 °C continuous with no coincident solar influence.
Display Operating Range	Readable: -20 to +60 °C with no coincident solar influence
Storage Range	Unpowered: - 40 to +85 °C
Humidity	5 to 95% relative humidity, non-condensing
External Magnetic Fields	Compliance with ANSI Standard C12.20:2002: American National Standard for Solid-State Electricity Meters.
RF Interference (RFI)	Compliance with ANSI Standard C12.20:2002: American National Standard for Solid-State Electricity Meters.
Electrostatic Discharge (ESD)	Compliance with ANSI Standard C12.20:2002: American National Standard for Solid-State Electricity Meters.
Insulation	Voltage / Current Inputs - 2.5 kV, in accordance with ANSI Standard C12.20:2002: American National Standard for Solid-State Electricity Meters.
Contact Inputs/Outputs	250 V RMS, 60Hz for one minute between each contact input/output circuit and any other contact input/output circuit 1 kV RMS, 60Hz for one minute between each contact input/output circuit and all comm circuits.

Communication Ports	
	RS-232/RS-485 and Ethernet - 1 kV RMS, 60Hz for one minute between the RS-232/485 circuits and all other circuits.
Modem	1.5 kV RMS, 60Hz for one minute between the modem telephone line circuit and all other circuits.
Surge Withstand (SWC)	
	In compliance with ANSI Standard C12.20:2002: American National Standard for Solid-State Electricity Meters.
Fast Transient (EFT)	In compliance with ANSI Standard C12.20:2002: American National Standard for Solid-State Electricity Meters.

Agency Standards and Certification

ANSI	ANSI C12.20:2002.
FCC	The internal modem complies with FCC Part 68
IEC	IEC 60687:1992 AC static watt-hour meters for active energy (classes 0.2S and 0.5S)

2. Meter Installation

Case Styles

Ci20 is available in the following case styles:

- Socket connected (S base), conforming to ANSI standard C12.10–1987, Section 5
- Adapter to convert S–base meter to bottom–connected (A–base) style

Size and Weight

S base: 5.5 pounds (Figure 2.1)

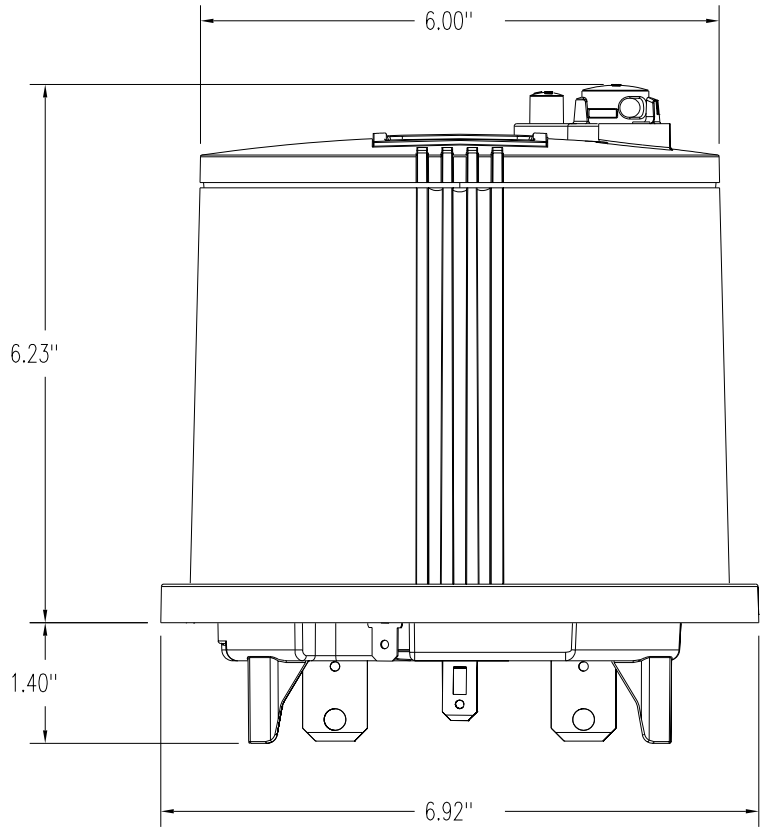


Figure 2.1 S–Base Meter Dimensions

Meter with A–base adapter (Figure 2.2 on page 2-2): 7.5 pounds.The total depth in front of mounting panel is 8.25″

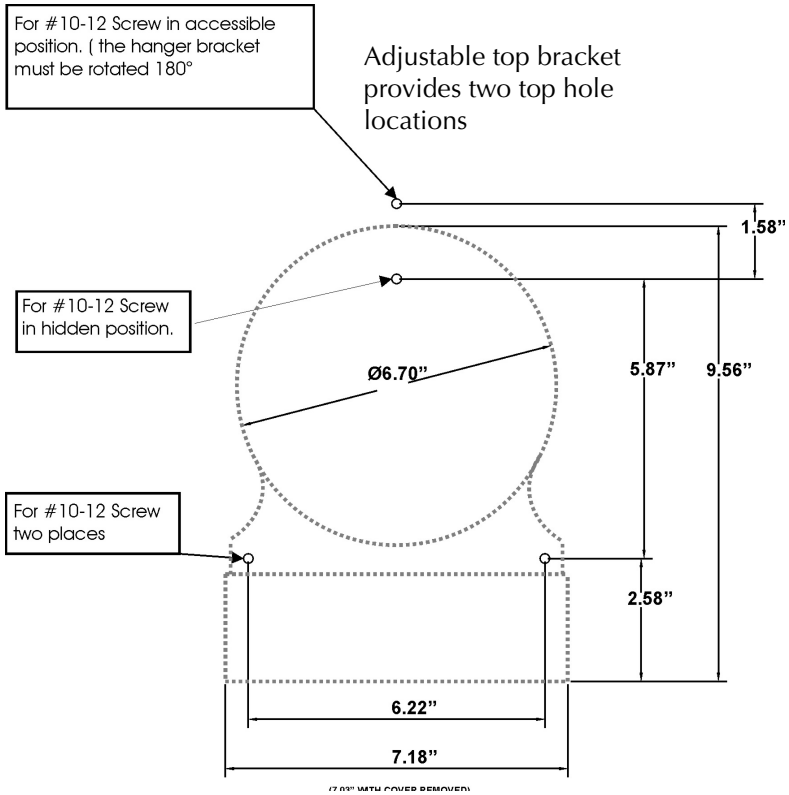


Figure 2.2 A–Base Adapter Mtg. Dimensions - S–Base Meter Installed

NOTE

When installing the meter locking ring on the A–base adapter, ensure that the ground tab on the right side of the adapter is securely fitted *under* the ring (Figure 2.3).

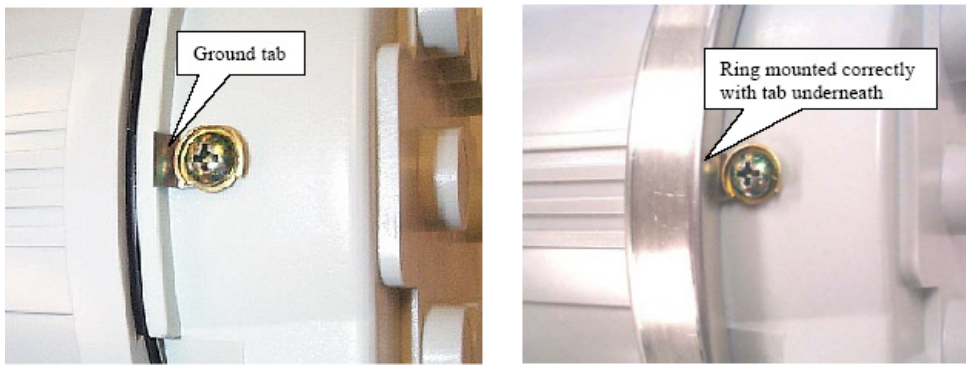


Figure 2.3 Ground Tab Location and Orientation

External Connections

Ci20 uses industry–standard power connector configurations consistent with the standards listed in "Ci20 Specifications" on page 1-8. Connections that are intended to be made and broken during normal meter operation (e.g. temporary data connections, Test Pulse pickup, etc.) are accessible without exposing the operator to live power terminals or conductors.

Power Connections

Refer to figures 2.4 through 2.13 for Industry Standard Power Connections

Wiring Diagrams

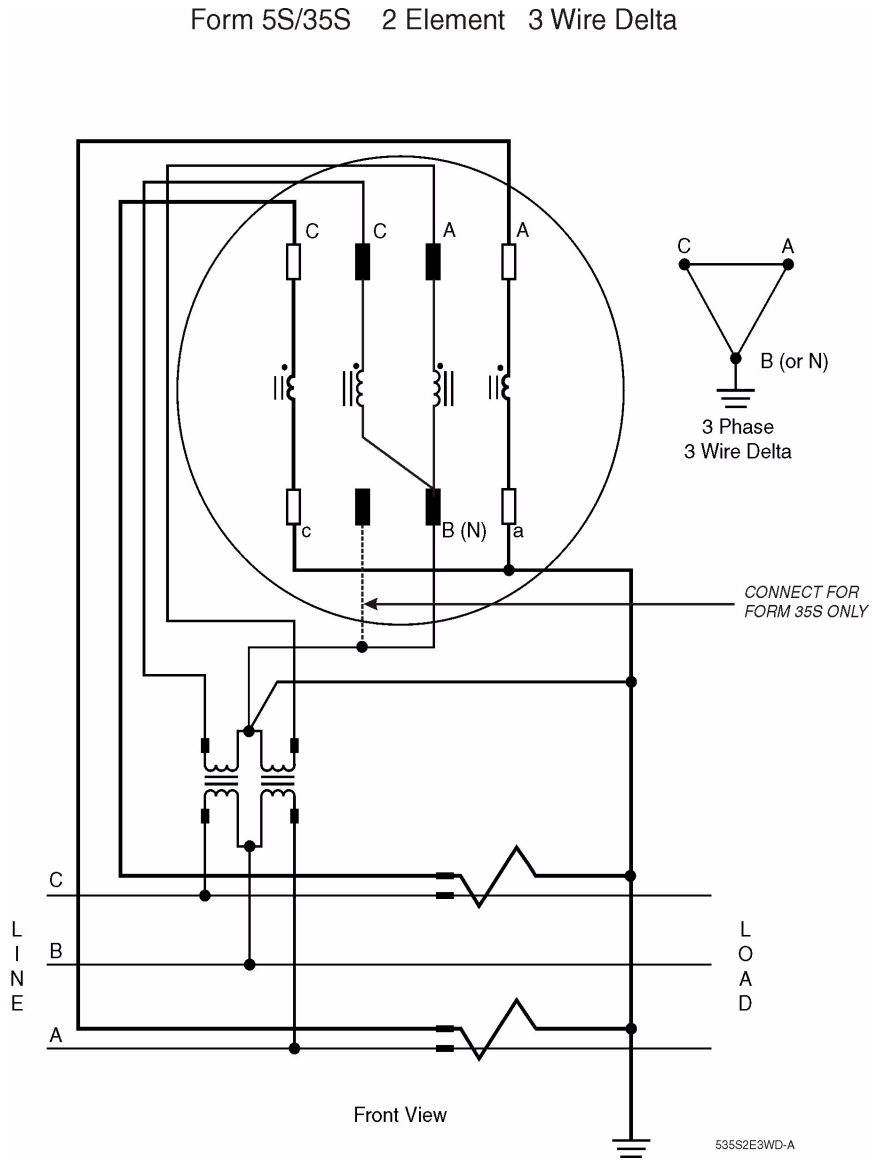


Figure 2.4 Form 5S/35S 2 Element 3 Wire Delta – Front View

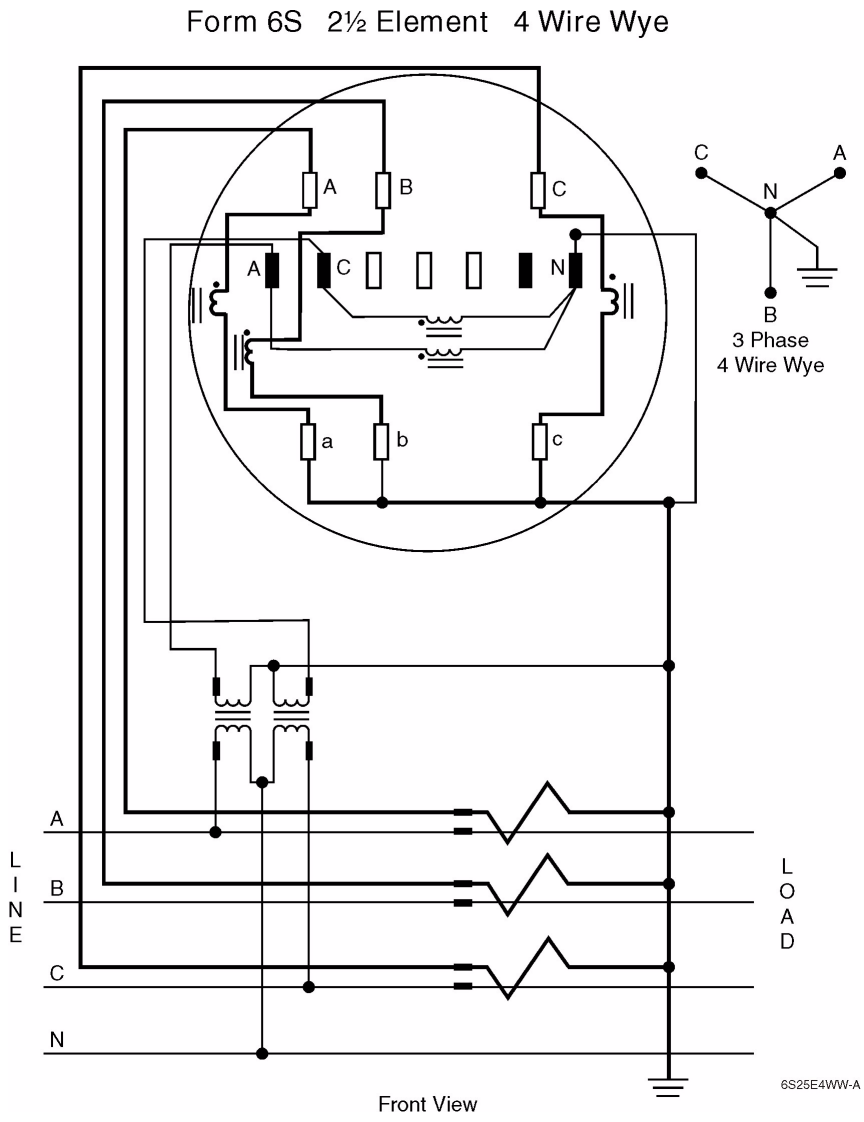


Figure 2.5 Form 6S 2½ Element 4 Wire Wye – Front View

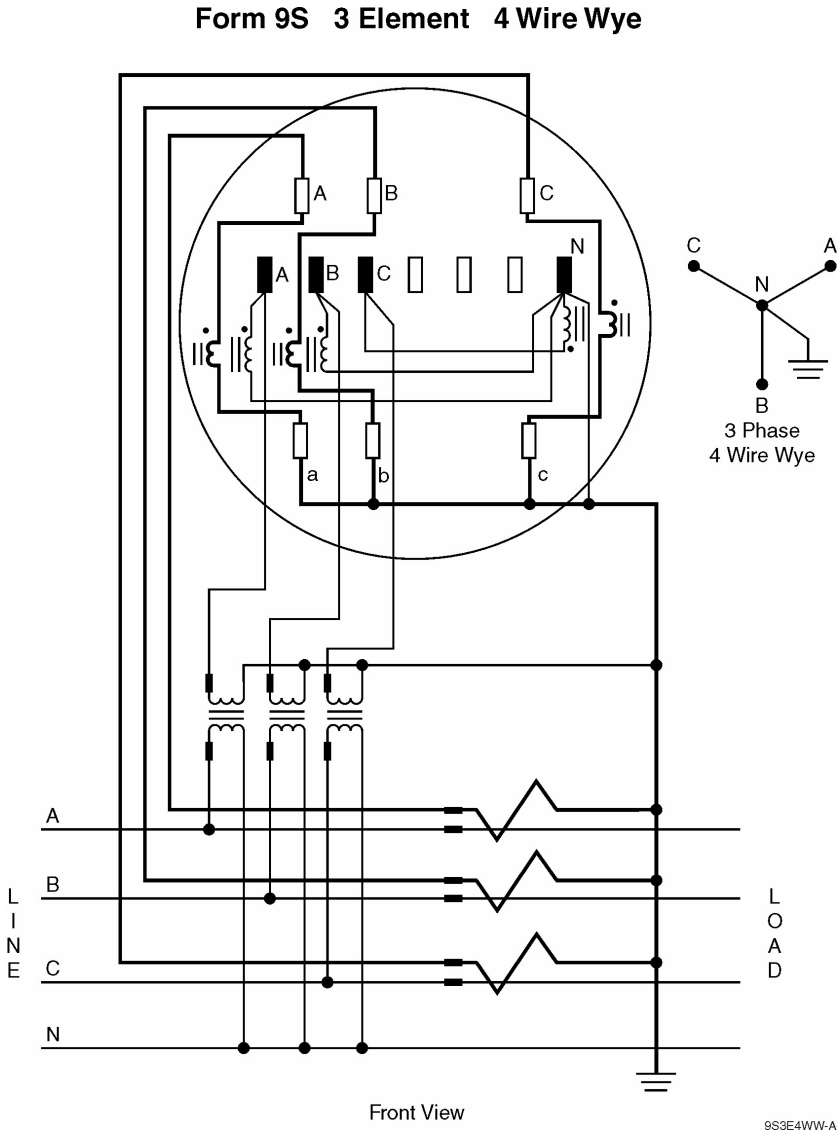


Figure 2.6 Form 9S 3 Element 4 Wire Wye – Front View

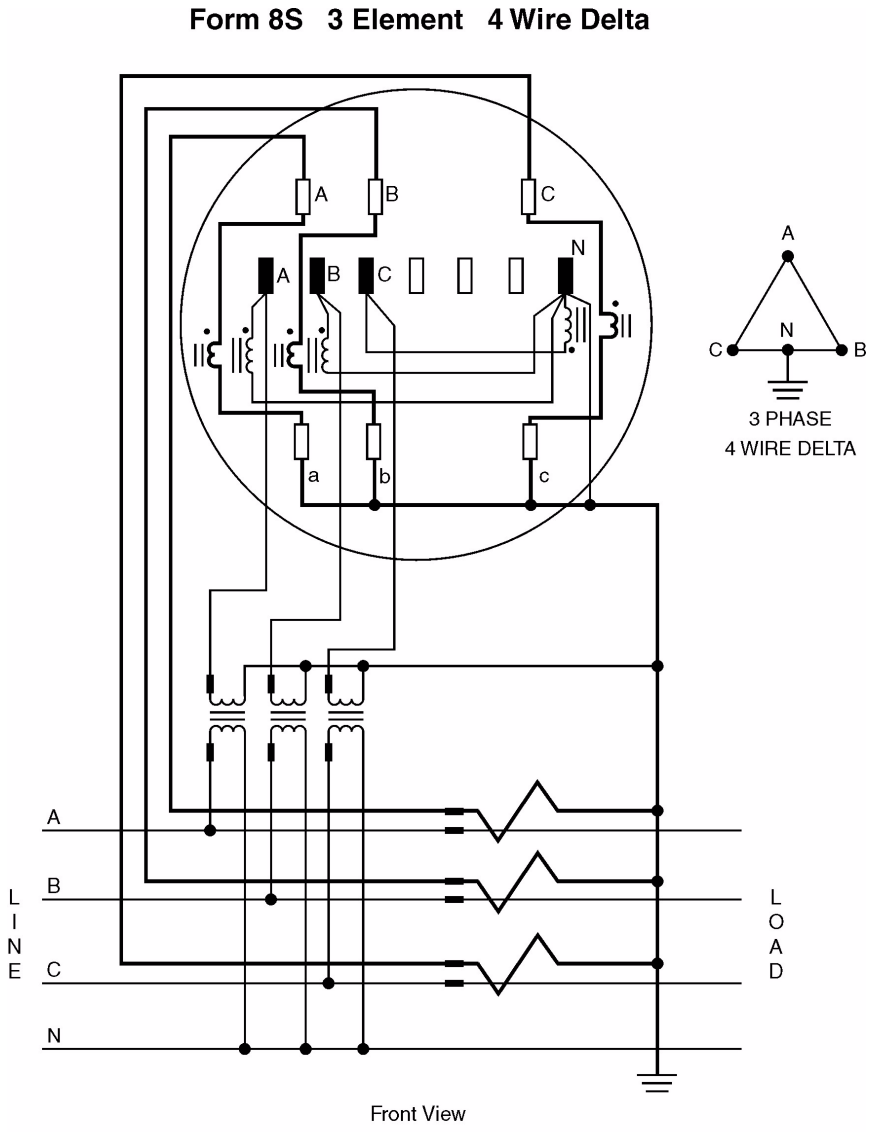


Figure 2.7 Form 8S 3 Element 4 Wire Delta – Front View

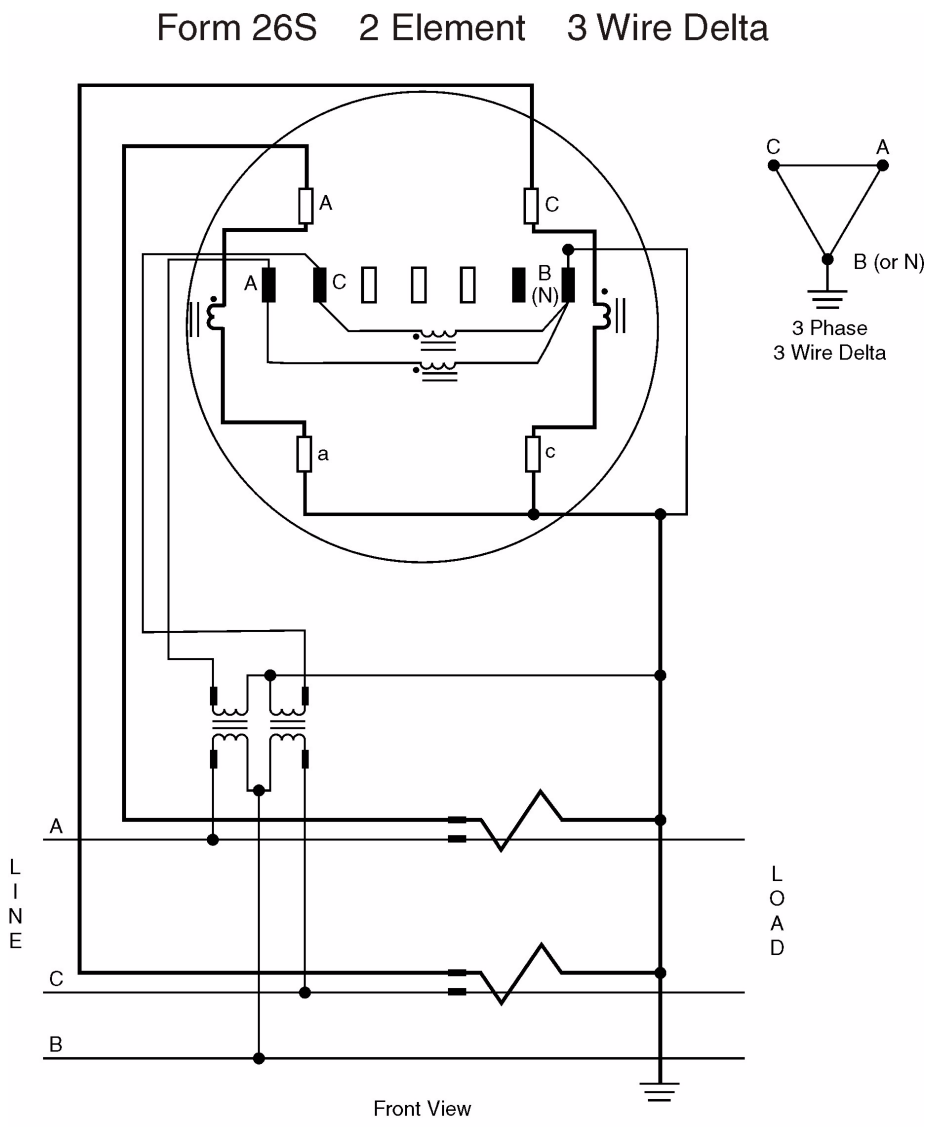


Figure 2.8 Form 26S 2 Element 3 Wire Delta - Front View

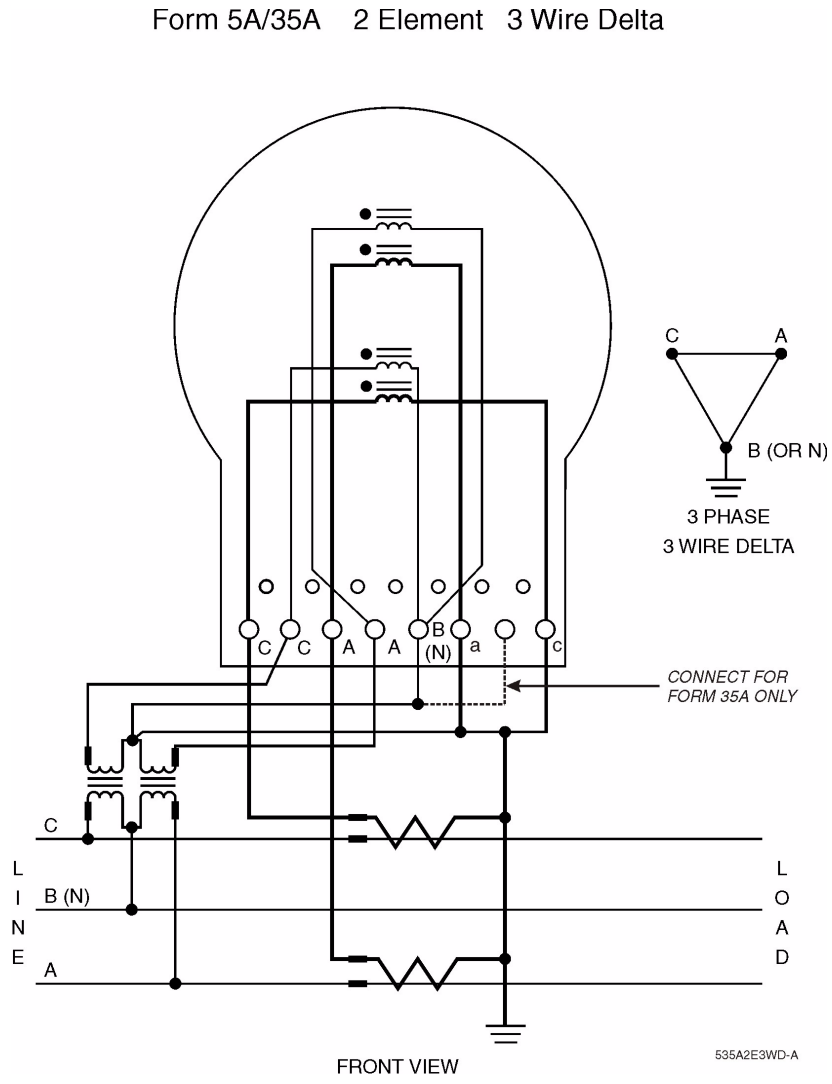


Figure 2.9 Form 5/35A 2 Element 3 Wire Delta – Front View

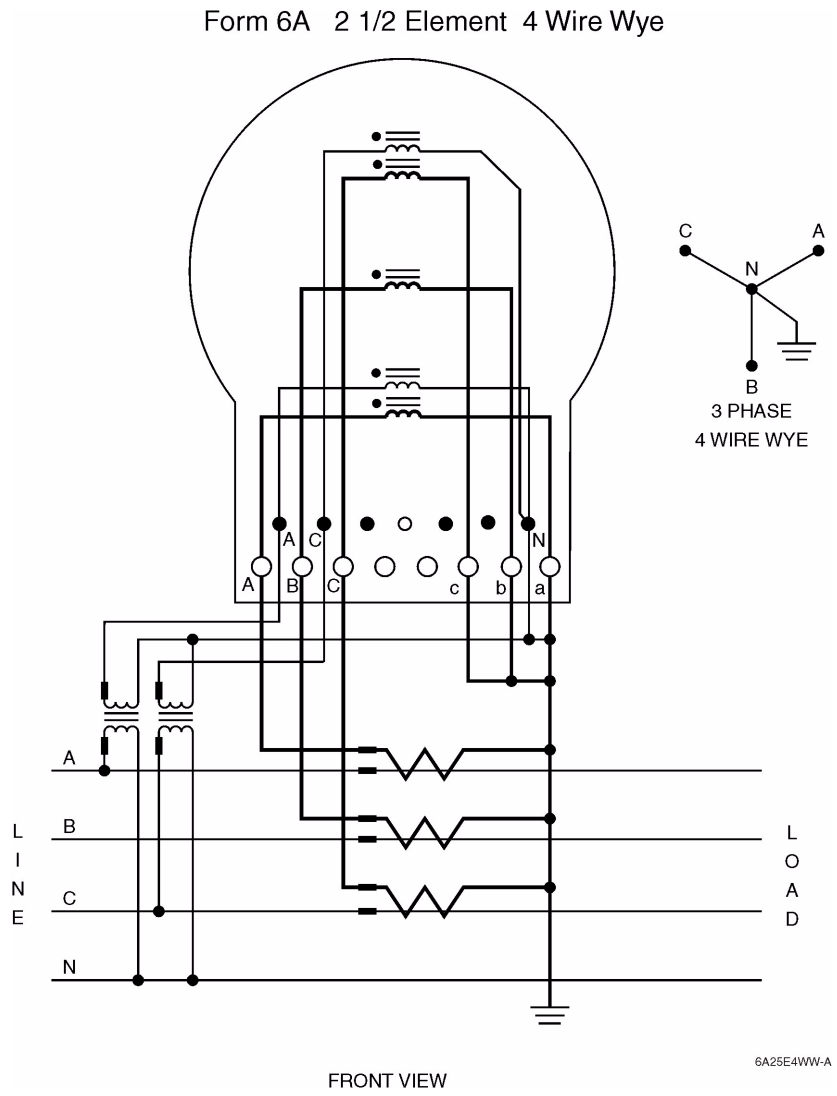


Figure 2.10 Form 6A 2 1/2 Element 4 Wire Wye – Front View

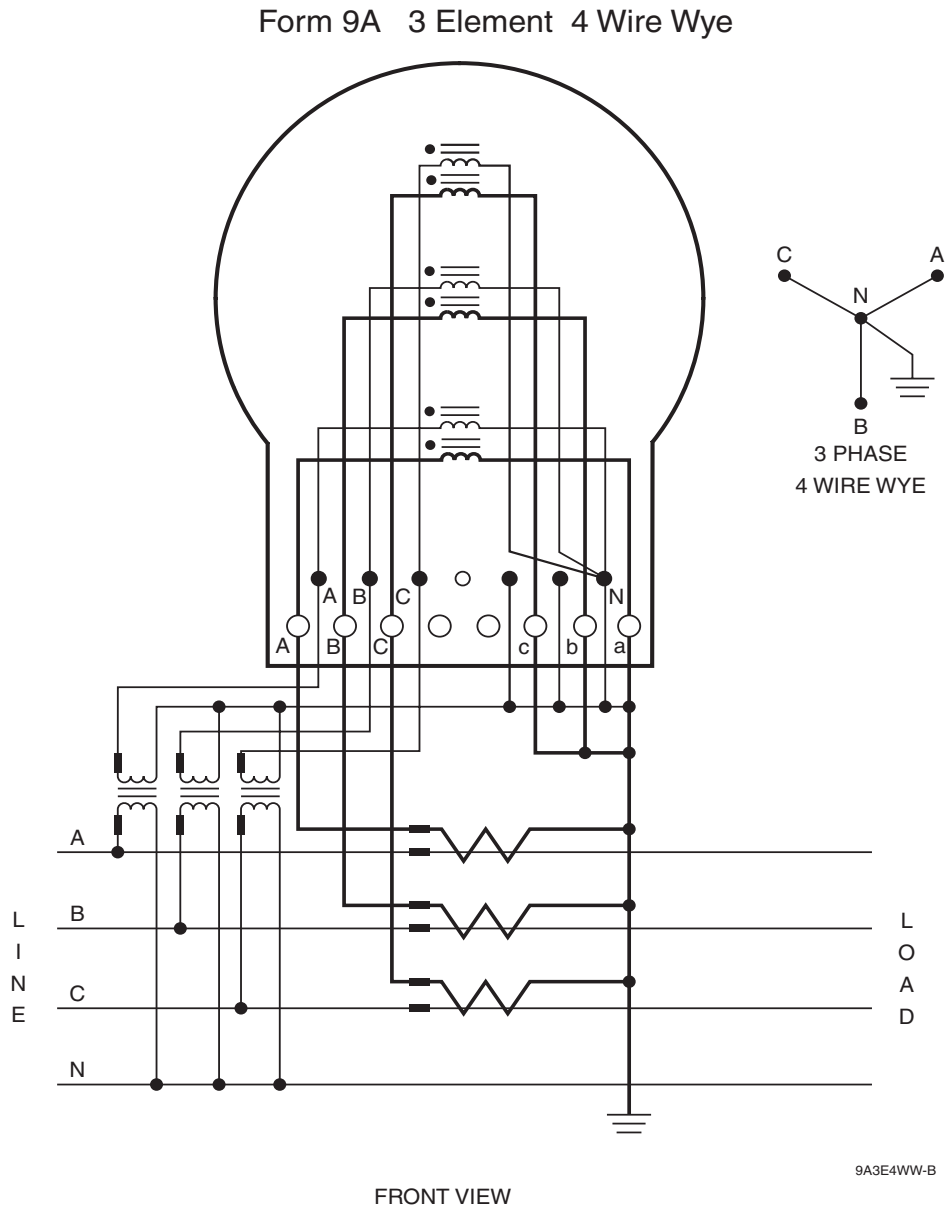


Figure 2.11 Form 9A 3 Element 4 Wire Wye – Front View

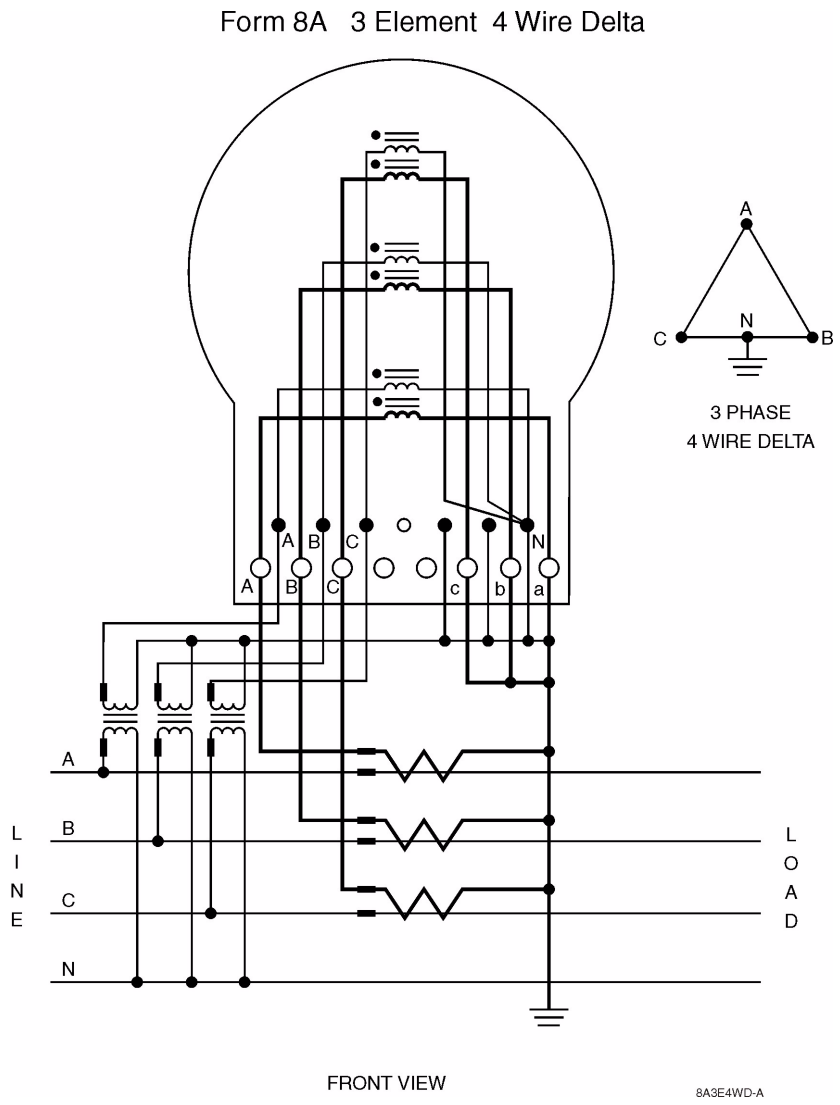


Figure 2.12 Form 8A 3 Element 4 Wire Delta – Front View

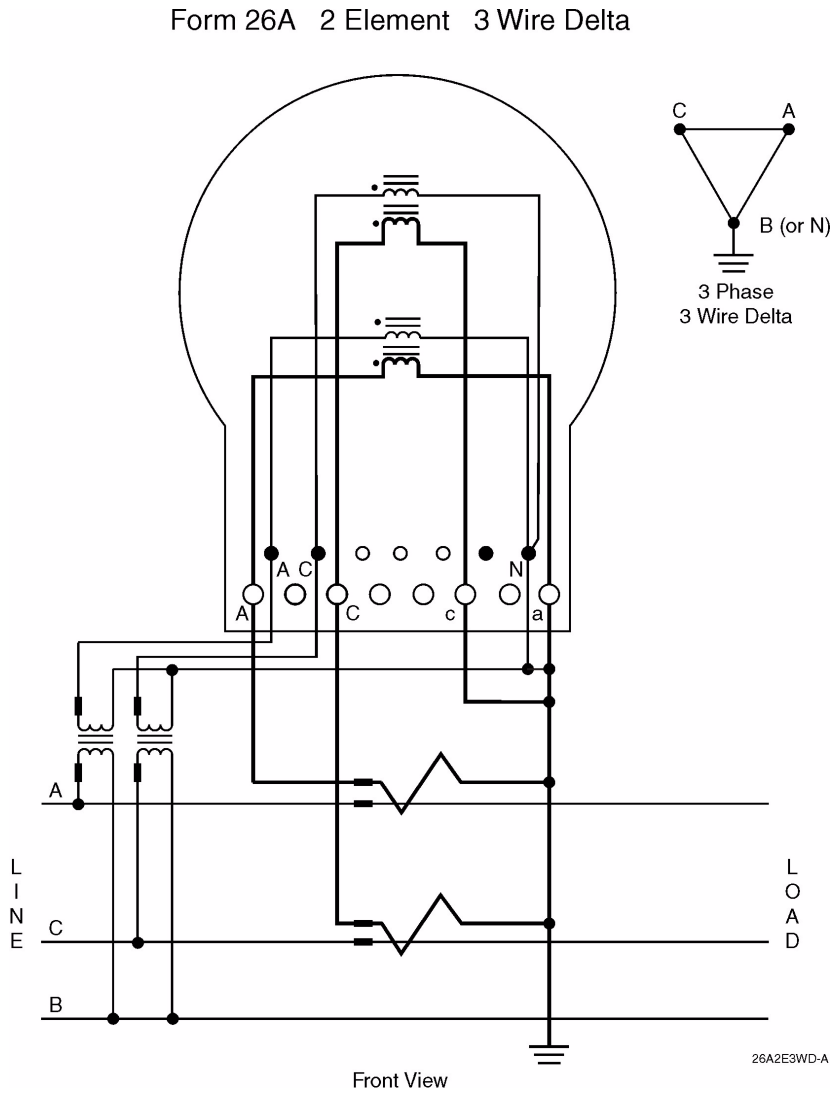


Figure 2.13 Form 26A 2 Element 3 Wire Delta - Front View

Input/Output/Communication Connections

Other *Ci20* electrical connections (e.g. Contact Outputs, Contact Inputs, Modem) are brought outside the meter as pigtail leads (S–base, A–base) of an appropriate wire gauge and insulation to maintain the electrical requirements of ANSI standards.

Reading the Wire Colors

All Input/Output wires are individually color coded to simplify identification of each signal. Each wire can have one, two, or three colors. The sequence of colors is read as follows (Figure 2.14):

- Body insulation is the first color
- Heavy stripe is the second color
- Thin tracer stripe is the third color
- Body/Heavy Stripe/Tracer Stripe

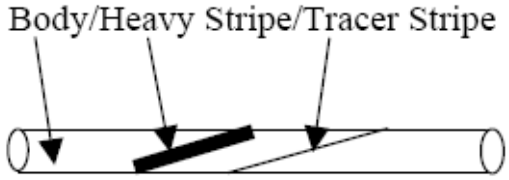


Figure 2.14 Wire Color Diagram

Grounding Recommendations

All signal inputs and outputs wired for extended distances from the *Ci20* must use shielded cables, with the shield grounded at one end. Ground the instrument PT and CT commons consistent with your company's wiring procedures.

Contact Inputs/Outputs

Ci20 can include an optional feature that consists of six channels, each configurable as an input or output.

Signal Input Options

Each input can be configured to perform any one of the following functions:

- Input to a pulse counter that is recorded as a channel in Load Profile. Each transition (make *or* break) is counted as a pulse.
- Interval synchronization pulse. Each *make* causes the Demand Interval and / or Load Profile (if so configured) to be re–synchronized.
- TOU Rate Override: Each *make* causes the present Time of Use rate to change to a user–configured *override* billing rate.
- Status Input: Each *make/break* of an external contact can be monitored by the meter and is logged in the Load Profile data report.
- Totalization input: Each *make* causes a configurable amount of energy to be added to a Totalization register's accumulated total.

NOTE

You may encounter excessive serial communication errors if the *Ci20* meter is configured to use Totalization inputs AND the meter is receiving pulses at a high rate. While the *Ci20* communication protocol uses error checking to prevent data corruption, communication times may be extended. To temporarily stop the interference, disconnect the contact inputs until communication is complete.

Ci20 is jumper configurable to provide a wetting voltage for the contact inputs. You may provide an external wetting source. The external source must have the following characteristics:

- Minimum ON voltage 10 VDC
- Maximum ON voltage 40 VDC
- Current limited to 50 mA

Ci20 debounces both *make* and *break* transitions on each contact input for at least 20 milliseconds. The maximum detectable pulse rate is 10 *transitions* per second.

For the S–Base and A–Base meter styles, *Ci20* contact input connections are provided via a multi–conductor cable. Table 2.1 lists the wire colors and connections to configure inputs.

Table 2.1 Contact Input Connections

Signal	Wire
IN1+	Wht/Blk
IN1-	Wht/Gry
IN2+	Wht/Yel/Blk
IN2-	Wht/Yel
IN3+	Wht/Org
IN3-	Wht/Brn/Blk
IN4+	Wht/Blu
IN4-	Wht/Blu/Blk
IN5+	Wht/Grn/Blk
IN5-	Wht/Red
IN6+	Wht/Red/Brn
IN6-	Wht/Red/Grn

Signal Output Options

Each output can be configured to perform any one of the following functions:

- Energy pulse output - KYZ Configurable for any consumption quantity or energy constant. Each transition is a pulse.
- End of Demand Interval Output - The output closes for one second when a demand (sub) interval closes.
- Site Monitoring Alarm output - The output closes when a Site Monitoring alarm condition is detected.
- Threshold Alarm output - The output closes when the selected Register exceeds a user–configured upper setpoint. The output re–opens when the Register falls below a user–configured lower setpoint. Applicable to outputs 1-4 only.
- Sag / Swell Alarm output - The output closes if the optional Sag / Swell Detection system determines that a voltage sag or swell event is in progress.
- System Error Alarm output - The output closes if a meter System Error condition is present.

Ci20 does not provide a wetting voltage for the contact outputs; external wetting must be applied. The *Ci20* contact closure outputs meet the following specifications:

- Maximum open – Circuit voltage is 200 Volts, DC or peak AC.
- Maximum closed – Circuit voltage drop is 2.5 Volts at 30 mA.
- In the closed state, the contact conducts in either direction.
- The maximum current rating for a closed contact is 50 mA.
- The contact outputs are TTL – Compatible when used with an external 4700–Ohm pull–up resistor to an external +5 VDC source.
- Maximum output rate is 20 transitions per second. A transition is defined as a single change of state, either open–to–close or close–to–open. This equates to 10 complete pulse cycles per second.

Ci20 contact output connections are provided via a multi–conductor cable. Table 2.2 lists the wire colors and connections to configure outputs.

Table 2.2 Contact Output Connections

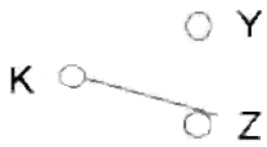
Signal	Wire
K1	Wht/Gry
Y1	Wht/Blk
Z1	Wht/Grn/Brn
K2	Wht/Yel
Y2	Wht/Yel/Blk
Z2	Wht/Org/Blk
K3	Wht/Brn/Blk
Y3	Wht/Org
Z3	Wht/Brn
K4	Wht/Blu/Blk
Y4	Wht/Blu
Z4	Wht/Grn
K5	Wht/Red

Table 2.2 Contact Output Connections

Y5	Wht/Grn/Blk
Z5	Wht/Red/Blk
K6	Wht/Red/Gren
Y6	Wht/Red/Brn
Z6	Wht/Org/Brn

Configuring Contact Outputs

When you set up a contact output (in *JEMWare*) for Normally Open, you are setting the *K-Y* section of the output for NO, and the *K-Z* section for NC. You can also set the output for reverse operation. That is, if you configure *JEMWare* for Normally Closed, you are setting the *K-Y* section for NC, and the *K-Z* section for NO (Figure 2.15).



Contact state shown with JEMWare configured for Normally Open

Figure 2.15 Contact State Shown with JEMWare Configured for Normally Open.

Communications

The *Ci20* has several communication selections available, consisting of:

- Optical (IR) Port
- Single Serial Port (RS-232/485)
- Dual Serial Port (RS-232/485)
- 2400 Baud Internal Modem
- 2400 Baud Internal Modem with Phone Home on Power Fail (PHPF)
- 2400 Baud Internal Modem with Single Serial Port (RS-232/485)
- 2400 Baud Internal Modem with Phone Home on Power Fail (PHPF) and Single Serial Port (RS-232/485)
- Ethernet Port
- Ethernet Port and Single Serial Port (RS-232/485)

All communication selections are options, except for the optical (IR) port, which is included on all meters. All communication selections can be used with all *Ci20* protocols, including: Binary, Modbus RTU, Modbus ASCII, DNP and ANSI Tables. The binary protocol is included with the meter. All other protocols are options.

Optical Port

Ci20 uses a front panel mounted Type 2 optical port. The physical configuration of the port is such that a magnetic mating probe can be attached with the cover on the meter. With the cover removed, a wire retaining clip is required. The *Ci20* optical port is shared with a Serial port (if provided) so only one can be used at a time. The optical port supports all *Ci20* protocols. (Modbus, DNP, ANSI Tables, Binary) and can be configured for 300, 1200, 2400, 9600 or 19200 baud communications.

Single Serial Port

The *Ci20* can be optionally equipped with a RS-232/485 serial port. It is jumper configurable for RS-232 or RS-485 Communications and supports all *Ci20* protocols. (Modbus, DNP, ANSI Tables, Binary) The serial port is shared with the optical port so only one can be used at a time. It can be configured for 300, 1200, 2400, 9600, 19.2K, or 38.4K bps communications.

Dual Serial Port

The *Ci20* can be optionally equipped with a dual RS-232/485 serial port. Each port is jumper configurable for RS-232 or RS-485 communications and supports all *Ci20* protocols. (Modbus, DNP, ANSI Tables, Binary) serial port #1 is shared with the optical port so only one can be used at a time. It can be configured for 300, 1200, 2400, 9600, 19.2K, or 38.4K bps communications.

RS-232 Mode

The RS-232 port is operated in half-duplex mode using four signal wires: Common, Transmit Data, Receive Data, and Request To Send. The *Ci20* serial output connections are provided via the multi-conductor cable. Table 2.3 lists the wire colors and connections to configure outputs. Figure 2.16 shows the connections.

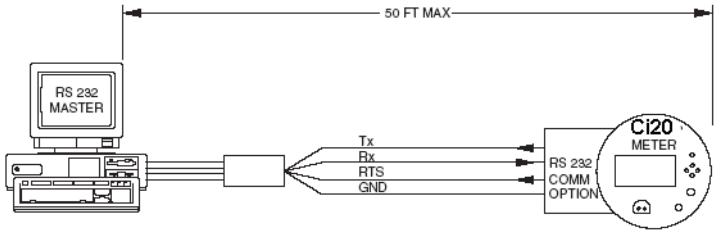


Figure 2.16 RS-232 Connection Diagram

Table 2.3 RS-232 Output Connections

Signal	Wire	Signal	Wire
Com	Wht/Pur		
TX1	Wht/Grn/Blu	TX2	Wht/Org/Grn
RX1	Wht/Red/Blu	RX2	Wht/Red/Org
RTS1	Wht/Brn/Blu	RTS2	Wht/Org/Blu
Serial Port #1		Serial Port #2 (used with Dual Serial Port Option)	

RS-485 Mode

The RS-485 port operates in half-duplex mode, for example, the transmit and receive signals share the same wire. The RS485 protocol permits up to 32 transceiver pairs to share a party line (Figure 2.17). Because RS485 communications are differential, the maximum reliable distance for RS485 communications is approximately 4000', however this length can vary depending on the type of cable used, external electrical interference, etc. A single twisted-pair of wires can connect up to 32 drivers and receivers for half-duplex communications. The *Ci20* serial output connections are provided via the multi-conductor cable. Table 2.4 lists the wire colors and connections to configure outputs. Figure 2.17 shows the connections.

The signals labeled *XMT/RCV(+)* and *XMT/RCV(-)* are a half-duplex pair that carry received data to the meter and transmitted data to the master.

There are no restrictions on where the meters are connected to the wires, and it is not necessary to have the meters connected at the ends. You can have other devices connected in the same string. However, the wire pair must be terminated at each end with a 120-Ohm resistor. If the *Ci20* meters are the end devices, this is accomplished by installing a jumper on the meter's communication board. If you have another type of device located at the end, refer to the instruction manual for that device. You may need to install the resistor externally.

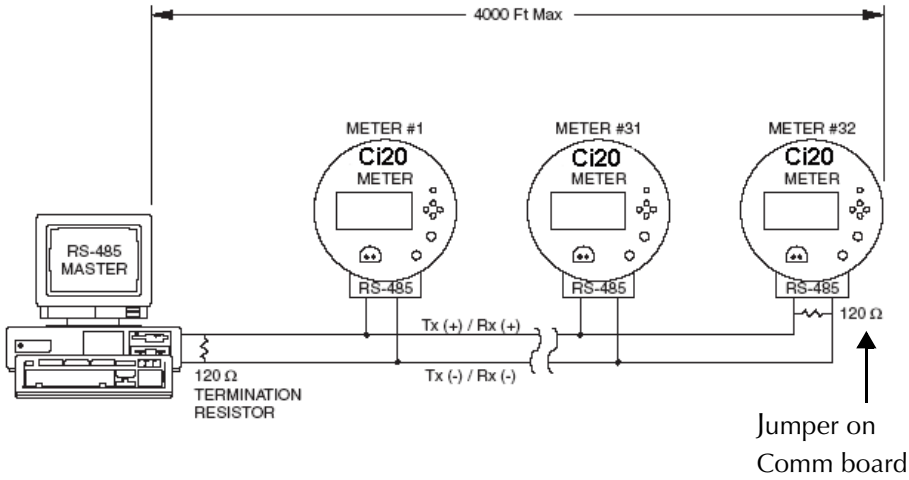


Figure 2.17 RS-485 Connection Diagram

Table 2.4 RS-485 Output Connections

Signal	Wire	Signal	Wire
Com	Wht/Pur		
XMT/RCV 1 (+)	Wht/Grn/Blu	XMT/RCV 2 (+)	Wht/Org/Grn
XMT/RCV 1 (-)	Wht/Red/Blu	XMT/RCV 2 (-)	Wht/Red/Org
Serial Port #1		Serial Port #2 (used with Dual Serial Port Option)	

Modem/Serial Port

Ci20 can be optionally equipped with an internal 2400 baud modem and a single serial port configurable for RS-232 or RS-485 communications. The serial port is shared with the optical port so only one can be used at a time. The serial port can be configured for 300, 1200, 2400, 9600, 19.2K, or 38.4K bps communications. Refer to "Dual Serial Port" on page 2-20 for additional details on the single serial port and RS-232/485 capabilities. The modem port works independently of the Serial Port so it can be used at any time. The modem supports all *Ci20* Protocols (Modbus, DNP, ANSI Tables, Binary).

The modem port is configurable via *JEMWare* for any communication address supported by the meter, and can be set for 300 to 2400 bits per second. A custom initialization string can also be configured to adapt the modem to specific conditions (see Appendix A "Ci20 Default Settings" for AT command codes). Modem tip and ring connections are made using a standard four-wire RJ11 phone jack.

Answer Modem

The *Ci20* internal modem can be programmed to determine the number of rings required before answering. An answer window, which restricts the modem to answering only during certain times of the day, is also programmable. The modem connects at any baud rate up to 14400 bps.

The modem can be configured for two different answering periods (number of rings) per day. When selected, it answers after a selected number of rings for a defined period each day, and after some other number of rings for the rest of the day.

The modem can also detect another telephone device sharing the line going off-hook, and surrender the line immediately, as long as the shared device is downstream of the modem.

Phone Home Modem

The *Ci20* internal modem has the capability of performing automatic dial-out (phone-home) calls. The meter can be programmed to automatically dial-out a preset number as a result of certain events including:

- Demand Threshold
- Site Alarm
- Threshold Alarm
- Data retrieval, and on a scheduled call-in for data retrieval (as supported by MV90)
- Power Fail (optional)

Each event can be set to call up to four different phone numbers. The modem can be configured to transmit an ASCII text message, or a series of DTMF tones. The modem can be set up to drop into slave mode, where it waits to be interrogated using whatever protocol the modem is configured to use.

Phone home operation calls the phone number and reports the information as a text message, without requiring any special processing software. Once the meter establishes communications, it sends a user-specified ASCII or DTMF response indicating the meter name and location, the time of call, and which events occurred. This can be logged either by a computer running terminal emulation software, or by a serial printer connected to the modem.

Call Home on Power Outage

Ci20 can be optionally equipped with an internal modem capable of initiating telephone calls for up to four separate telephone numbers and transmitting a message in the event of a loss of power at the meter. The telephone numbers and message are software configurable using *JEMWare*.

The internal battery pack that supports this option uses long life lithium cells, however if the need arises, the batteries can be easily replaced by removing the meter top cover (see Chapter 5 "Maintenance").

FCC Compliance of the Internal Modem

This equipment complies with Part 68 of the FCC rules governing communications devices. On the meter housing is a label that contains the FCC registration number and Ringer Equivalence Number (REN) for this equipment. This information must be provided to the telephone company, if requested.

Connect this equipment to a standard RJ11 Telco jack. The REN is used to determine the quantity of devices that can be connected to a telephone line. Excessive RENs on the telephone line may result in the devices not ringing in response to an incoming call. In most cases, the sum of the RENs must not exceed five. To be certain of the number of devices that may be connected to your specific line (as determined by the number of RENs), contact your local telephone company.

If the modem causes harm to the telephone network, the telephone company notifies you as soon as possible. In addition, you are advised of your right to file a complaint with the FCC, should this be necessary. The telephone company may make changes in its facilities, equipment, operations, or procedures that could affect the operation of the equipment. If this happens, the telephone company provides advance notice for you to make the necessary modifications so that your service is not interrupted.

If trouble is experienced with this modem, please contact Ametek Power Instruments for repair and warranty information. If the trouble is affecting the telephone network, the telephone company may request that you remove the equipment from the network until the problem is resolved. Do not attempt to repair this equipment. The modem cannot be used on public coin service provided by the telephone company. Connection to Party Line Service is subject to tariffs. Contact your state public utility commission, public service commission, or corporation commission for information.

Ethernet/Serial Port

Ci20 can be optionally equipped with an ethernet port and a single serial port configurable for RS-232 or RS-485 communications. The serial port is shared with the optical port so only one can be used at a time. The serial port can be configured for 300, 1200, 2400, 9600, 19.2K, or 38.4K bps communications. Refer to above for additional details on the single serial port and RS-232/485 capabilities. The ethernet port works independently of the serial port so it can be used at any time.

The ethernet port is configurable via *JEMWare* for any IP address or it can obtain an IP address automatically using DHCP. The Ethernet port supports all *Ci20* protocols. (Modbus, DNP, ANSI Tables, Binary)

Up to four simultaneous connections are possible, permitting each user to access whatever metering information is necessary. Up to four passwords can be configured in the meter to restrict or allow certain functions per user. For example, one user can be granted access to display registers while a second user has access to load profile data and a third simultaneous user has access to all data and configuration settings.

The *JEMWare* configuration software can connect to the meter via ethernet, serial or optical port. Ethernet connections are provided through a standard RJ45 jack.

Communication Protocols

The *Ci20* supports Binary, Modbus RTU, Modbus ASCII, DNP and ANSI Tables protocols. Additional information is provided in the instruction manual Appendix for Modbus, DNP and ANSI Tables protocols.

Binary Protocol

The Ci20 Binary Protocol command set allows for the following functions:

- Configure the meter
- Read registers
- Read Load Profile
- Check health and status
- Set the time
- Preset registers
- Perform Billing Period Reset
- Read recorded events
- Read Site Diagnostic Data
- Reload the meter register's operating firmware (remote firmware upgrade)
- Validate the user's authorization to perform certain functions. (Password protection)

Configuration commands are structured such that any one command can be used to change a configurable item without causing the meter to stop running due to a mismatch in the total configuration. For example, reconfiguring the TOU schedule for all Rate 1 periods without a Rate 1 register does not cause the meter to stop functioning.

Communications and Password Protection

The *Ci20* supports up to four passwords, three with definable privileges.

The first *master* password always has total access to meter functions.

Privileges for each of the other passwords are configurable for any or all of these categories:

- Read Normal register list
- Read Alternate register list
- Read any Profile Data, Register Freeze
- Set Time
- Perform Billing Reset
- Enter Test, Site Diagnostic, or Calibrate Mode
- Preset Registers
- Configure meter identity (ID strings, CT / PT ratios, etc.) and Comm parameters
- Configure TOU schedule
- Configure everything else not itemized
- Read configuration Data
- Change Password

Option Board Hardware Configuration

Any Ci20 option, except for those noted as factory configuration or configured at manufacture, can be installed by a user with the following capabilities:

- Intermediate skill as an electronic technician,
- knowledge of static-protection and electrical safety techniques.
- Familiar with the proper use of common tools (e.g.screwdrivers, wire strippers or cutters, wrenches, etc.) and equipment (e.g. Voltmeter) used in electronics, including static reduction equipment such as grounding straps or mats.
- Soldering equipment is NOT required.

The Ci20 meter design, with its plug-together boards, requires few tools for maintenance.

CAUTION

All meter work must be performed at static-protected workstations WITH POWER REMOVED. The technician must follow properly prescribed static-control practices. Refer to Appendix C "Electrostatic Discharge" for more information.

Board Removal/Installation

Globe Removal

To perform this task:

Remove power from meter.

Remove all wire seals from the locking ring of the meter globe, and then remove the ring. You do NOT need to remove any seals from the RESET button.

Turn the globe counter-clockwise approximately 1 inch to disengage it from the base.

Carefully slide the globe forward away from the base and set it aside.

See Figure 2.18 for meter with globe removed.

Figure 2.18 Meter with Globe Removed

Internal Housing Disassembly

To perform this task:

Remove the top cover of the housing by unscrewing two Phillips-head screws (Figure 2.18).

Carefully lift the cover off, paying particular attention to the RAM battery wires. Do not unplug the battery, or data is lost!

Front Cover Disassembly

The Ci20's communication board and I/O board can be changed and/or reconfigured in the meter shop with a few simple procedures. Because the register/metrology board is calibrated to the current transformers and power supply board, Ametek Power Instruments recommends that the meter be returned to the factory if changes to these components are necessary.

The Ci20 clock/RAM battery is designed to last the life of the meter under normal storage and usage conditions. If the battery needs replacement, or you would like more information on any Ci20 components, call Ametek Power Instruments' Technical Support staff at 800-950-5503.

- Ensure proper grounding for static protection.
- Press the left and right mounting tabs that hold the front panel assembly onto the meter.

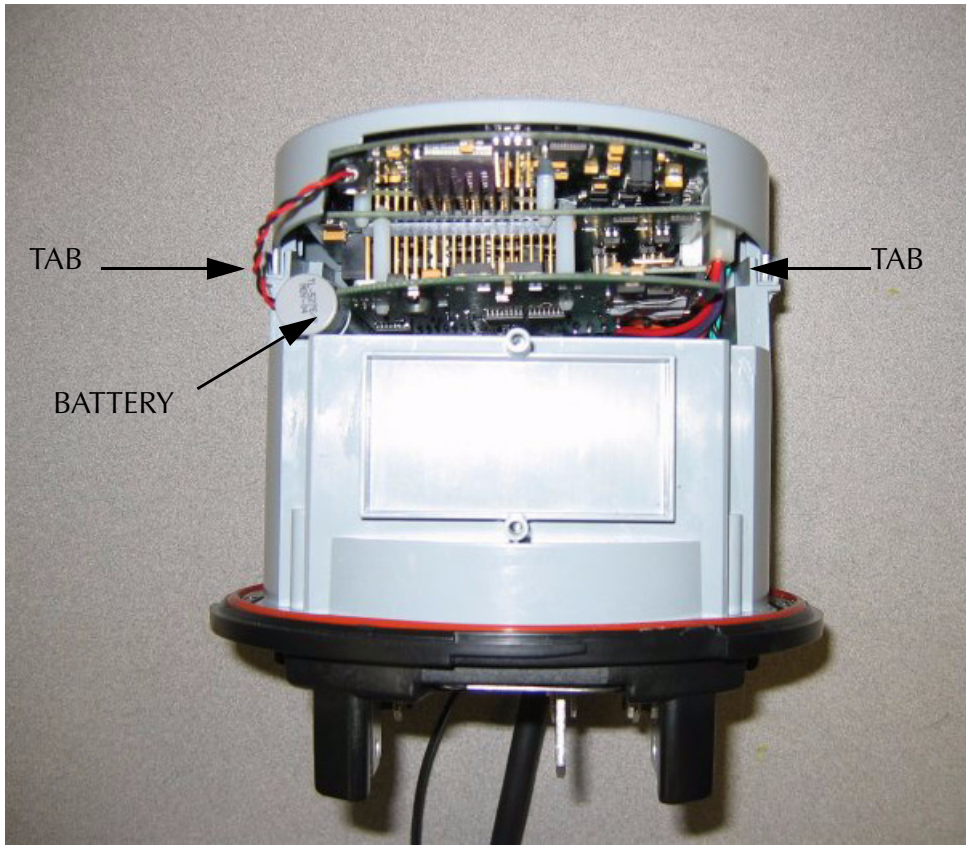


Figure 2.19 Ci20 Front Cover Removal

- Lift the battery out of its holder. Do not disconnect the battery from the Register/Metrology Board or data will be lost.

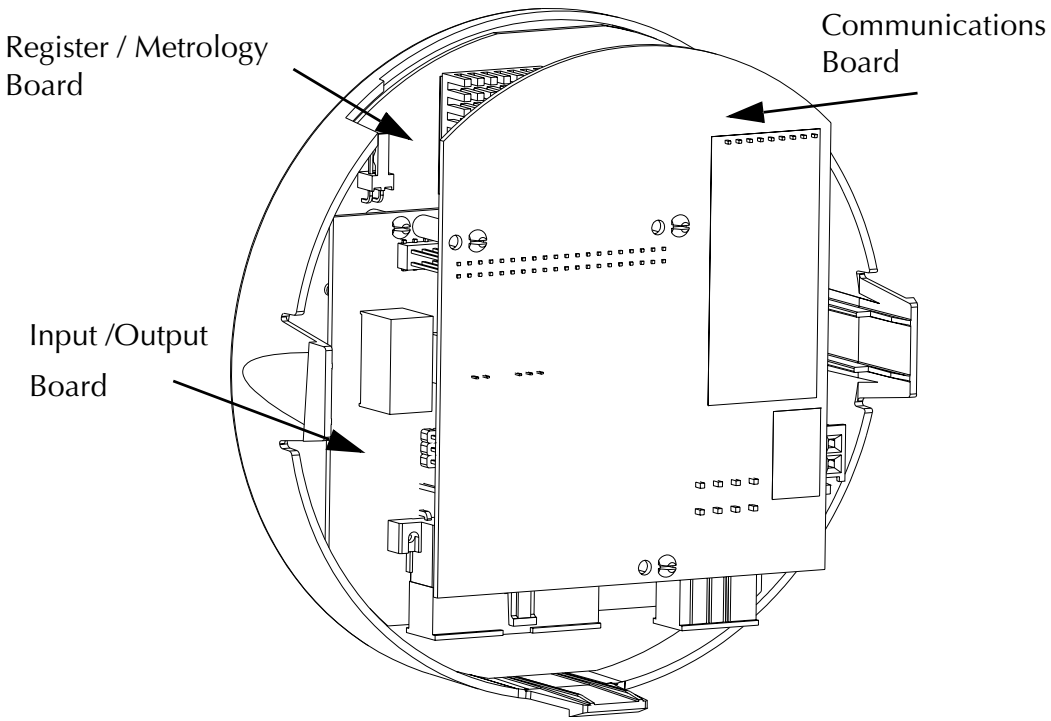


Figure 2.20 Ci20 Front Cover

Communication Board (Option)

All communication selections are configured with JEMWare software, except for RS-232 / RS-485 operation, which are jumper configurable. This applies to the following communication option boards:

- Single/Dual Serial Board
- Modem/Serial Board
- Ethernet/Serial Board

To remove the communication board:

- Disconnect all comm. Cables from the communications board. Pull the Comm board off of the stand-offs and 40 pin header.
- Place the Comm board on an antistatic mat.

To replace or install the communication board:

- Carefully line up the 40 pin header on the communication board socket. To assist with this, move the circuit board spacer provided to the top of the header to align the pins for contact.
- Re-attach the standoffs and all cables.

Single/Dual Serial Board:

Each channel may be configured for either RS-232 or RS-485.

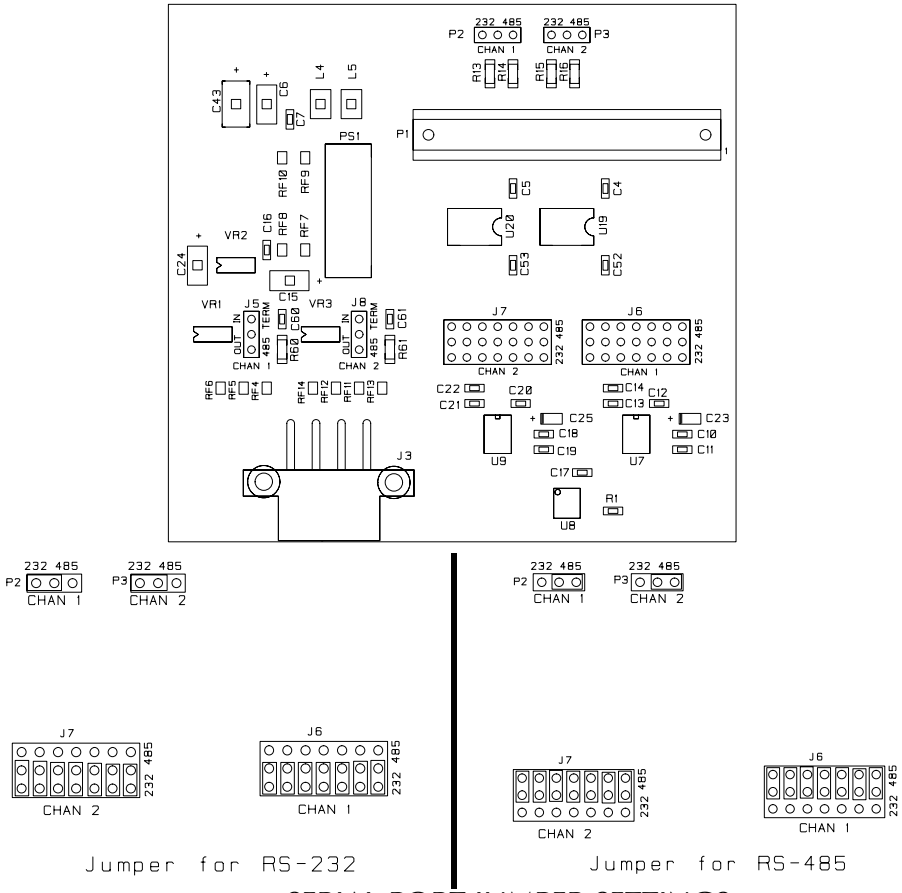
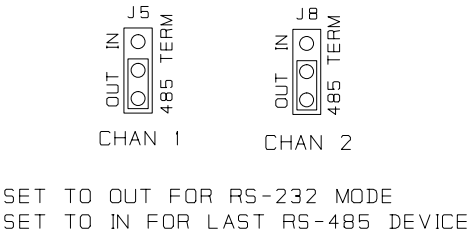


Figure 2.21 Ci20 Single / Dual Serial Communication Board

RS-485 Terminators:



Set the terminator J5 or J8 to IN for the last channel in an RS-485 chain. Set the terminator to OUT for all RS-232 applications.

Modem/Serial Board:

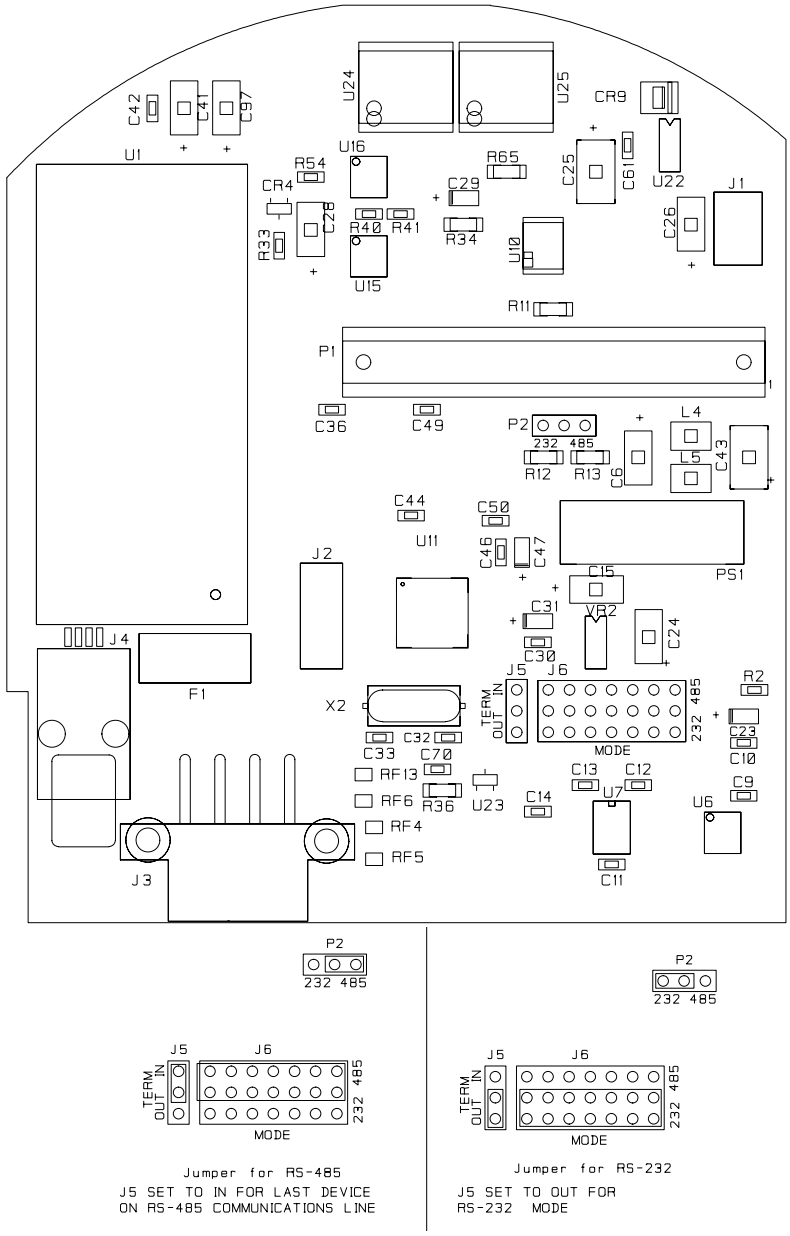


Figure 2.22 Ci20 Modem/Serial Communication Board

RS-485 Terminators:

Set the terminator J5 to IN for the last channel in an RS-485 chain.

Set the terminator to OUT for all RS-232 applications.

Ethernet/Serial Board:

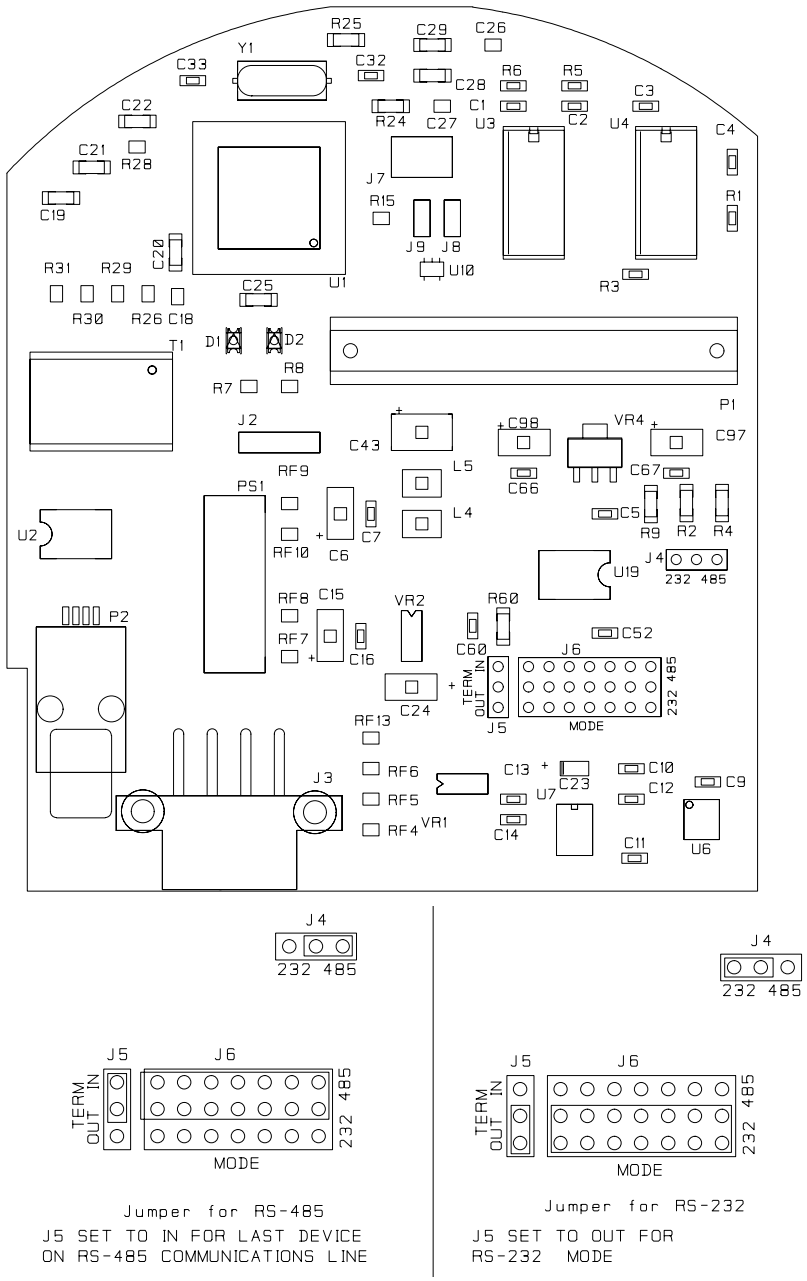


Figure 2.23 Ci20 Ethernet/Serial Communication Board

RS-485 Terminators:

Set the terminator J5 to IN for the last channel in an RS-485 chain.

Set the terminator to OUT for all RS-232 applications.

Input/Output Board (Option)

The six channel I/O option board can be configured per channel as an input or output. If equipped with the wetted input option, the input contacts can be jumpered to the internal 12VDC power supply, eliminating the need for external voltage.

To remove the I/O option board:

If a Communications Board is installed, remove it per the above procedure.

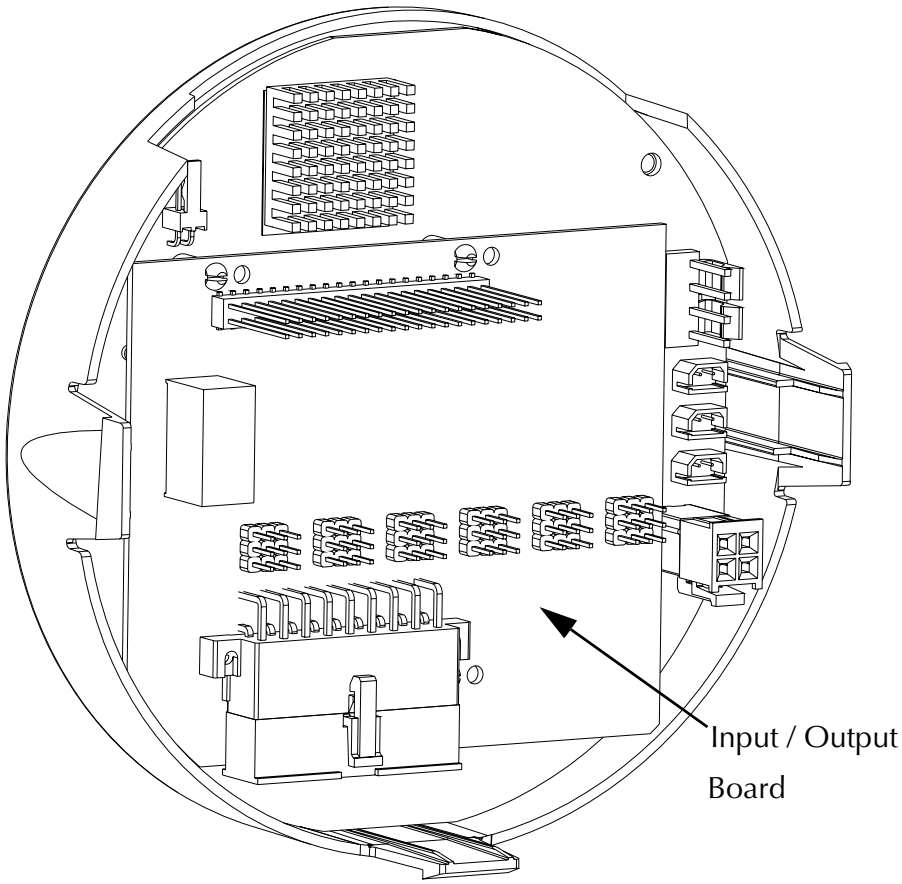
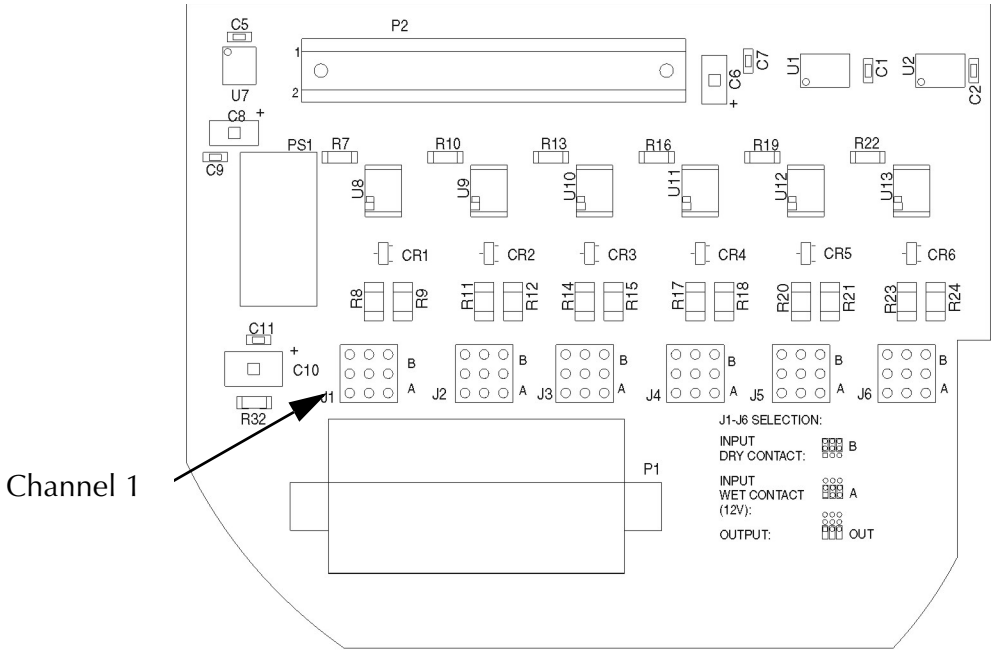


Figure 2.24 Ci20 Front Cover with Communication Board Removed

- Firmly grasp the sides of the I/O board at the top of the board and pull it off of the stand-offs and 40 pin header.
- Place the board on an antistatic mat.



J1-6 JUMPER SETTINGS:

Position	Configuration
B	Dry Contact Input
A	Wet Contact Input
OUT	Output

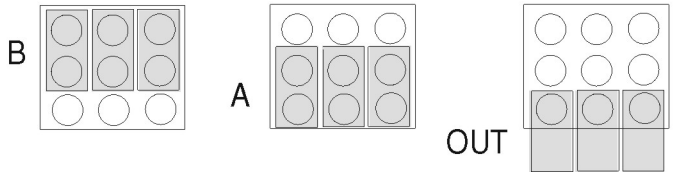


Figure 2.25 Ci20 Input/Output Board

I/O Board hardware configuration:

J1thru 6 are jumpered as follows:

- Use "A" position for Wet Contact Input (No external voltage required)
- Use "B" position for Dry Contact Input. (external voltage required)
- Use "Out" position when configured as an OUTPUT

To replace the I/O option board:

- Carefully line up the 40 pin header on the I/O Option board socket. To assist with this, move the circuit board spacer provided to the top of the header to align the pins for contact.
- Re-attach the standoffs and all cables.

3. Meter Operation

Meter Nameplate and User Interface

Meter Nameplate

The meter's nameplate (Figure 3.1) provides general information about the meter including model number, form, class, voltage, frequency, wiring configuration (3-Wire or 4-Wire), test Amps, and the K_t (test pulse constant in WH/count).

Figure 3.1 Ci20 Front View - Globe Removed

Meter Configuration

All of the parameters that determine the meter's operation can be set by using the *JEMWare* software. *JEMWare* includes a file management system for storing configurations, configuration editing screens for setting the various parameters, and communication channel setups to program the meter. *JEMWare* provides the ability to read the existing configuration from the meter and to read the time on the meter through serial communications. The *JEMWare Software Manual* 1083-602 describes each programmable parameter.

NOTE

You can use the latest version of *JEMWare* to open a configuration file saved with a prior version, or to read the configuration from a *Ci20* meter that was programmed with a prior version. If you do this, however, you must verify all settings in the configuration before saving it or programming it into a meter. Verify the settings by opening each item in the Meter Settings menu and reviewing the settings. This allows you confidence that the correct settings are in place and also allows *JEMWare* to insert appropriate default settings for features that may not have been present in the older version of *JEMWare*.

User Interface

Ci20 includes a user interface consisting of the front panel display and keypad. The user interface facilitates all the tasks most commonly performed at the meter without using a separate computer. Some configuration functions are settable directly from the meter, while others requires setup through the *JEMWare* software program.

The hardware Security Key must be installed in the Metrology board to access the keypad functions of the meter. Refer to Chapter 5 "Maintenance" for a complete description of the Security Key features.

The keypad, located at the right side of the meter's faceplate, consists of seven buttons (Figure 3.2). With the meter cover (or globe) in place, you can only press **READ**, which allows you to scroll through and view the meter's display registers and reset.

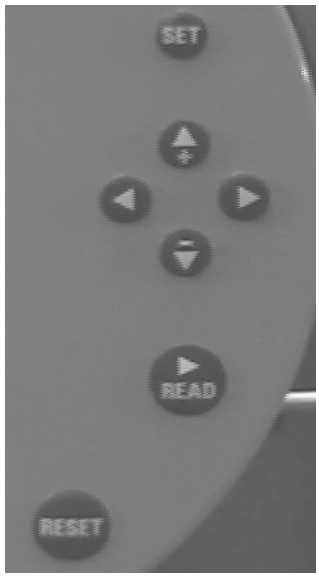


Figure 3.2 Ci20 Front Panel Controls

The RESET button performs a Billing Period Reset and is available on a closed meter. To use the interface:

1. Remove any external seals.
2. Twist the button 90° clockwise to unlock it.

   A separate Security Key on the Metrology board is provided which can disable just the Reset button. Refer to Chapter 5 "Maintenance" for further information.
3. Remove the meter cover (or globe), all configuration buttons are accessible. Enter setup menus by pressing any one of the four arrow buttons.

The *Ci20* Display

The display (Figure 3.3) is divided into several sections that are dedicated to show specific meter functions or operations.

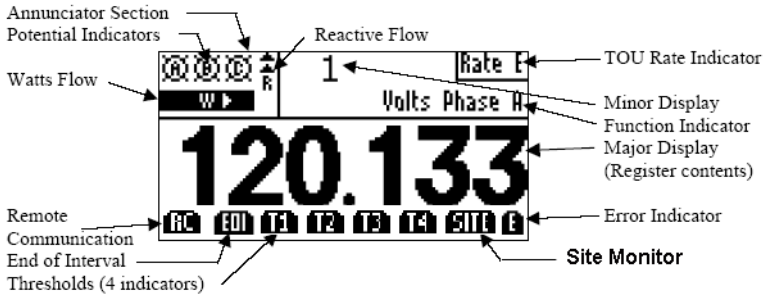


Figure 3.3 Ci20 LCD Display Layout

Major Display — The large six or eight-digit numeric display on the *Ci20* displays measurement registers and the measurement quantity. Measurement registers that appear on this display are configurable for up to three decimal places and for three or more significant digits, with lead zero blanking.

Minor Display — The smaller three-digit numeric display on the *Ci20* is used for identification codes, register sequence numbers, or other user-configured indications. For registers in user-defined display lists, the you can assign up to a three-digit identifier to each displayed item.

Function Indicator — This indicates information relative to the highlighted menu item. This indicator displays simple text and is customizable for each user-assigned register in *JEMWare*.

TOU Rate Indicator — This is programmable to indicate the Time of Use rate (A-H) associated with any displayed measurement. Registers associated with the Total rate leave this blank.

Annunciators — These are visible regardless of what is displayed on the major or minor numeric displays and indicates the following items as symbols:

- *Potential Indicators* - Each of the three possible voltage inputs (A, B, and C) on the *Ci20* has a corresponding Potential Indicator. This indicator is visible whenever the corresponding voltage input exceeds 20 V. The only time that a Potential Indicator turns off is:
  - If the corresponding voltage input is below 20 (+5, -0) Volts
  - If the meter Auxiliary Power is off
  - If a blank display is shown
- *Load Rate Indicator(s)* - The upper left section of the display includes a sequentially moving arrow indication of the direction and rate of energy flow for Watts and Reactive (VAR or Q). Left to right arrows indicates Watts delivered; right to left indicates Watts received. In a similar manner, bottom to top arrows indicate Reactive Lagging; top to bottom indicates Reactive Leading.
- *End of Interval Indicator* - The display provides a momentary indication of the end of a Demand Interval or Subinterval. On occurrence, a flag appears in the lower left for at least one second.
- *Error Indicator* - When the meter detects an error, a flag appears in the lower right corner of the display.

- *Register Threshold 1 - 4* - Appears in the bottom row when one of the user-configured Threshold conditions is exceeded. There is a separate indicator for each of the four Threshold settings.
- *Site Monitor* - Appears in the bottom row when one of the user-configured Site Monitor conditions is in effect.

Cold Start

If *Ci20* circuit boards have been replaced or software options have been installed, a cold start procedure must be performed.

CAUTION

A cold start erases all register and load profile data. The communication and configuration parameters are reset to factory defaults (see Appendix A "Ci20 Default Settings").

Upgrading *Ci20* operating firmware automatically performs a cold start at the end of the upgrade procedure. After a cold start, reconfigure the meter using *JEMWare* configuration software to program the meter for your specific application.

To perform a cold start:

4. Remove power from the meter, and then remove the meter globe.
5. Simultaneously press the UP and DOWN arrow buttons while applying power to the meter, until the *Ci20* logo appears.

Default Time Displays

When a cold start is performed, certain time and date displays in the meter (for example, Date of Peak Demand) contain a default time/date until the meter records an actual value. This *non-value* displays as midnight, January 1, 1970. In other words, a time register shows 00.00.00 and a date register shows 01.01.70.

If you see a display with this particular time and date, this is simply an indication that the meter has not received a valid setting yet.

Navigating the Display Menus

In standard operation, the *Ci20* display shows the measured electrical quantities and various other monitored parameters. However, the display can be switched into the Setup mode, which uses a simple menu structure for access to the meter's multiple features. Some menu items are *read-only* such as health status indicators, while others are editable: time, date, communications, etc. Through a series of front panel button operations you can directly configure many of the simpler meter functions.

NOTE

The front panel keypad can be *locked out,* depending on your company policy. See Chapter 5 "Maintenance" for information on Security Keys.

The *Display* menu is divided into logical groups of features and categories. Table 3.1 shows all menu functions.

Table 3.1 Display Menu Layout

Menu Column 1	Menu Column 2	Menu Column 3	Description of Operation	Editable Feature
Settings	*Identity*	*VTR*	Voltage Transformer Ratio:1	Y
		CTR	Current Transformer Ratio:1	Y
		Service	*4Wire-Y, 4Wire-D, 3Wire-D,* etc.	N
		Program ID	ID name from *JEMWare*	N
		Firmware Rev	Revision Number	N
		Display	Select six-digit or eight-digit main display with leading zeroes or leading blanks	Y
	Demand	*Interval*	Time in hours/minutes	N
		Subinterval	Time in hours/minutes	N
	Date/Time	*Time*	*XX:XX:XX* (24 hour format)	Y
		Date	*XX.XX.XX* (format configured in *JEMWare*)	Y

Table 3.1 Display Menu Layout (Continued)

Menu Column 1	Menu Column 2	Menu Column 3	Description of Operation	Editable Feature
	Health	*Batt Status*	*OK, Warning*	N
		Configuration	*OK, Error*	N
		Site Monitor	*Normal, Alarm*	N
		Threshold 1	*Normal, Alarm*	N
		Threshold 2	*Normal, Alarm*	N
		Threshold 3	*Normal, Alarm*	N
		Threshold 4	*Normal, Alarm*	N
	Opt/S1	*Address*	Decimal address, *Not Installed*	Y
		Baud	*300, 1200, 2400, 9600, 19200, 38400*	Y
		Protocol	*Ci20 28, DNP, Modbus RTU, Modbus ASCII, ANSI Tables, DPMS, TEC-870-102, Not Installed*	Y
		Type	*RS232, RS485*	N
		RTS ON time	Time in mSec between RTS ON and Tx start	Y
		RTS OFF time	Time in mSec between Tx end and RTS OFF	Y
		Turnaround	Time in mSec between Tx end and Rx start (RS485 only)	Y

Table 3.1 Display Menu Layout (Continued)

Menu Column 1	Menu Column 2	Menu Column 3	Description of Operation	Editable Feature
	Mod/S2	*Type*	*RS232, RS485, Modem*	N
		Address	Decimal address>, *Not Installed*	Y
		Baud	*300, 1200, 2400, 9600, 19200, 38400, Not Installed*	Y
		Protocol	*Ci20 28, DNP, Modbus RTU, Modbus ASCII, ANSI Tables, DPMS, TEC-870-102, Not Installed*	Y
		RTS ON time	Time in mSec between RTS ON and Tx start	Y
		RTS OFF time	Time in mSec between Tx end and RTS OFF	Y
		Turnaround	Time in minutes with no comm activity before modem disconnects	Y
	Ethernet	*Type*	Indicates the presence of the Ethernet option	N
		IP Address	Current IP address	N
		Netmask	Current netmask	N
		MAC Address	MAC address	N
Preset	*Normal*	Register list	Value in each register, Editable for numeric registers	Y
	Alternate	Register list	Value in each register, Editable for numeric registers	Y
I/O	*Contacts*	*Channel 1 through Channel 6*	Ke Value, *EOI, Site Alarm, Threshold Alarm, Not Installed*	N

Table 3.1 Display Menu Layout (Continued)

Menu Column 1	Menu Column 2	Menu Column 3	Description of Operation	Editable Feature
Configure	*Test Mode*	*Register list*	*Press SET to enter Test Mode **	N
	Comm	*Opt/S2*	*Press SET to send character out port*	N
		Mod/S2	*Press SET to send character out port*	N
	SiteChk	*Va, Vb, Vc*	*Press SET for phasor diagram*	N
		Ia, Ib, Ic	*Press SET for phasor diagram*	N
		Va, Ia	*Press SET for phasor diagram*	N
		Vb, Ib	*Press SET for phasor diagram*	N
		Vc, Ic	*Press SET for phasor diagram*	N
	Display	*Display Test*	*Press SET for display pixel check*	N

**Only KWH and KVAR registers are editable and the value displayed while editing is the calibration adjustment (+/- 5%), not the reading

To access the *Display* menus:

1. Remove the meter globe; this may require breaking a seal. Turn the globe counter-clockwise to disengage it from the base and set it aside.
2. Press any one of the four arrow buttons on the right front of the meter, and the display immediately goes to the *Menu Mode*. If it does not, the Security Key can be removed to gain access. Refer to Chapter 5 "Maintenance" for information about Security Keys.

   The lower portion of the display is now divided into three menu columns. Starting at the leftmost column:

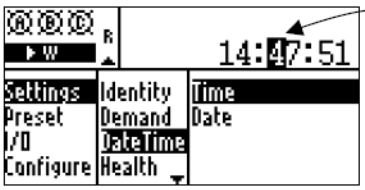
   - *Settings* - Highlighted areas are presently active. Use the:
     - UP and DOWN arrow buttons to scroll through the first column choices. The second column adjusts to the function selected in the first column.
     - Right arrow button to move the cursor to the second column. The third column choices are now visible.

   In this manner, you can scroll up, down, left, or right, to place the cursor on the specific function you want to view or edit. Press **READ** any time you want to return to the normal display.

3. Select the correct menu feature and the value appears in the upper section.
4. Press **SET** to edit the value.

NOTE

Some functions can be edited, some cannot. If it is changeable, a highlighted cursor appears in the upper right section (Figure 3.4).



Typical example of setting the meter's clock. Note the minute digit "4" is highlighted for change.

Figure 3.4 Setting the Meter Clock

5. Press the **+** button or the **-** button to decrement the active digit.

NOTE

Press READ at any time to cancel the operation without making any changes.

6. Press the right arrow button to select the next digit and continue selecting and incrementing/decrementing digits until the desired setting is configured.
7. Press **SET** and the meter accepts the change and automatically returns to the lower menu section.
8. Use the left arrow to back through the menus and return to the normal display, or press **READ** to escape.

NOTE

If the meter is left in the Menu Mode without user interaction (i.e. pressing buttons), it automatically reverts to normal display operation after one minute (factory default setting). The length of time can be configured for up to 60 minutes by changing the *Preset Mode timeout* under *Display Setup* in *JEMWare*.

Register Display Modes

The meter registers can be grouped in three different display modes: *Normal*, *Alternate*, and *Test*. *Ci20* can display up to 50 total registers, consisting of Normal and Alternate. Normal Mode is the *usual* display mode of the meter. If display Scrolling is enabled (via *JEMWare*), the Normal Mode registers are sequentially displayed at a user-configurable rate.

NOTE

If the meter is configured for a scrolling display, to halt it press and holding SET for five seconds. This stops the display indefinitely. Pressing READ returns the display to scroll mode.

Alternate Mode registers are a second group of registers that do not appear in the *Normal Mode*. These registers are used as a convenient method to group storage registers, or any other user purpose.

To make these registers available:

- Press and hold **READ** for at least two seconds.

To manually scroll *Alternate Mode* registers:

- Momentarily press **READ**.

To return to *Normal* registers:

- Press and hold **READ** again for two seconds.

To manually scroll through *Normal Mode* registers:

- Momentarily press **READ** to step to the next register.

While in Normal or Alternate Mode, if the meter detects a System Error condition (for example, a Battery Warning), each time a new register is presented, an error message appears briefly before the actual register value. Performing a Billing Period Reset clears the System Error reports.

Test Mode is used for testing the accuracy of the meter. Refer to Chapter 4 "Test & Calibration" for a complete explanation of Test Mode.

NOTE

When in Test Mode, only the Test Mode registers update. The standard metering registers and load-profile data do not accumulate. The normal metering functions are suspended until Test Mode is exited.

Test Mode

The *Test Mode* allows you to apply test voltages and currents to the meter without having them affect Normal or Alternate registers, or Load Profile. Test Mode also allows adjustment of meter registration.

During Test Mode, the following conditions exist:

- Normal and Alternate registers stop accumulating. Peak, Coincident, and Time/Date of Peak registers may continue to update, but they behave as if there is zero power applied to the meter.
- Load Profile stops accumulating and storing interval records. Any partial interval counts accumulated before entering Test Mode are retained, and are stored with a Test Mode event record when Test Mode ends.
- Test Registers accumulate power and behave as expected for the type of register. For example, Time-of-Use registers respond only during the correct rate period, Demand registers update on normal demand interval timing, etc.
- The Optical Port emits Test Pulses.
- Energy (KYZ) pulses continue to operate as before.

Refer to Chapter 4 "Test & Calibration" for a complete explanation of Test Mode operation.

NOTE

If the meter has been configured with a *Test Mode timeout* via *JEMWare*, the display automatically reverts to normal operation after the designated length of time without user interaction. The factory default setting is 30 minutes.

Display Format

Because of the nature of register values, some register types are formatted differently than others. You can configure the number of digits for display and the number of digits to the right of the decimal point.

Therefore, each register type can be categorized into one of two behaviors (Table 3.2).

Table 3.2 Register Behaviors

Item	User-Configured Format (potential overflow)	Fixed Format (unaffected by user configuration)
Instantaneous	Consumption	Time of Peak
Average PF	Cumulative Peak Demand	Date of Peak
Peak Demand	Continuous Cumulative Demand	
Coincident Demand		

Table 3.2 Register Behaviors

Thermal Demand		
Peak Thermal Demand		
	Predicted Demand	

You can choose to display Consumption, Peak Demand, Coincident Demand, Cumulative Demand, Continuous Cumulative Demand, and Predicted Demand with leading zeroes.

Changing Meter Configurations

The meter front panel offers some basic setup features, however *JEMWare* software is used to make most changes in a meter configuration. Refer to Publication 1083-602 for complete details about using the program.

Certain features of the *Ci20* meter are forced to be re-initialized when portions of the meter's configuration are changed. This section summarizes the changes that force a re-initialization. When a new configuration is loaded into a meter, the meter determines individually if each section has changed from the currently stored configuration. These features are re-initialized ONLY if the particular configuration sections are different. Re-initialization means that the data in that particular register is set to zero.

Display Registers

The Display Registers feature includes the following parts of the *Ci20*:

- Registers in the Normal display list
- Registers in the Alternate display list
- Registers in the Test display list
- Register Thresholds
- Site Monitor alarms
- Totalization registers

The following configuration sections, if modified, cause the Display Registers feature to re-initialize, erasing all previous data:

- Normal display list
- Alternate display list
- Test display list
- Demand settings
- Primary Scaling settings, including changing VT Ratio or CT Ratio from the meter front panel
- Register Threshold settings
- Demand, Load Profile Interval Timing settings
- Totalization channel setup

The Load Profile features, which does not include individual Event Logs, are erased and re-initialized if these configuration sections are modified:

- Demand, Load Profile Interval Timing settings
- Load Profile channel assignments
- Primary Scaling settings, including changing VT Ratio or CT Ratio from the meter front panel
- Totalization channels

The Energy Pulse feature re-initializes if the Energy pulse channel assignments configuration section is changed.

Display Menus

This section details how to use the meter display menus. The categories are listed in the order they appear on the screen. Refer to Table 3.1 on page 3-6 for a full list of the available menus.

Some display menu features are read-only and some are directly editable. The meter settings editable via the front panel are limited to the most common functions. ALL *Ci20* settings can be configured using *JEMWare* software. Refer to publication 108-382 to configure a meter via software.

Ci20 uses two security keys to limit access to the front panel pushbuttons. Depending upon your company's policy, you may need to *unlock* the keypad. Refer to Chapter 5 "Maintenance" for instructions about Security Keys.

VTR/CTR

To read and change the Voltage Transformer Ratio and the Current Transformer Ratio:

1. Select *Settings > Identity > VTR (or) CTR*.
2. Edit the existing setting by pressing **SET** and using the arrow buttons to enter a new ratio.

NOTE

Changing the meter's VT or CT Ratio causes Load Profile pulse constants, Energy Pulse constants, and Site Monitor thresholds to be re-scaled automatically so that they maintain the same settings in Primary units. It also causes all numeric registers to be erased and re-initialized.

Service, ID, Revision

To read the information about how the meter is configured:

- *Select Settings > Identity > Service* or *Program ID* or *Firmware Rev*:

Service	Available types are 4-Wire Wye, 4-Wire Delta, 3-Wire Delta, Network, Open Delta, 3-Wire Wye
Program ID	The meter identification that appears in the register list.
Firmware Rev	The version number of the firmware installed in the meter.

Demand Intervals

To read the Demand Interval and Subinterval lengths in hours and minutes:

- *Select Settings > Demand > Interval* or *Subinterval.*

These settings can only be edited by using *JEMWare* software.

Date / Time

Ci20 uses a real-time clock capable of maintaining time and date with a very high resolution. With the on-board battery, it maintains time even when auxiliary power is off.

The *Ci20* clock can be configured to use the local power line frequency as a time synchronization method, or to use the internal frequency reference (crystal oscillator). If *Ci20* is configured for line sync, it continues to keep time even if the Phase A reference voltage disappears. If auxiliary power is absent, the meter reverts to the internal crystal time base.

The *Ci20* clock accuracy, when configured for line sync, is dependent on the line frequency accuracy. When configured for crystal sync, *Ci20's* timekeeping accuracy is three minutes per month or better.

The date and time can be set from the front panel or via serial communication command. *Ci20* accommodates the differences in the way time is adjusted for daylight savings time internationally through the *JEMWare* program.

NOTE

Date and Time can only be edited through the Settings menu, not via Presets.

Setting the Date and Time

The date and time can be set either through the front panel (Figure 3.5), or through serial communications via *JEMWare* software. Since this may affect interval timing or TOU, this session is logged as a manual Time Set event.

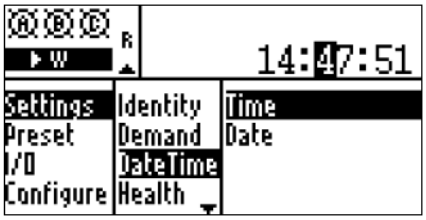


Figure 3.5 Setting the Date and Time

Date Set

The front panel procedure is:

1. Remove the front panel and meter globe.
2. Enter the *Date Set Mode* by pressing any arrow key.
3. Using the arrow keys, select *Settings* > *Date Time* > *Date*, then press **SET**. The date appears as *XX.XX.XX* and is a configurable sequence through *JEMWare*. The first digit in the line is highlighted.
4. Press the **+** button or the **-** button to increment/decrement the highlighted digit.

5. Press the right arrow button to select the next digit.
6. Continue selecting and incrementing/decrementing digits until the desired date is entered.
7. Press **SET** to accept the new value. The meter automatically returns to the menu.
8. Use the left arrow to back through the menus and return to the normal display, or press **READ** to escape.

Time Set

The front panel procedure is:

1. Remove the front panel and meter globe.
2. Enter the *Time Set Mode* by pressing any arrow key.
3. Using the arrow keys, select *Settings > Date Time > Time*, then press **SET**. The time appears as *HH.MM.SS* in 24-hour format. The first digit in the line is highlighted.
4. Press the **+** button or the **-** button to increment/decrement the highlighted digit.
5. Press the right arrow button to select the next digit.
6. Continue selecting and incrementing/decrementing digits until the desired time is entered.
7. Press **SET** to accept the new value. The meter automatically returns to the menu.
8. Use the left arrow to back through the menus and return to the normal display, or press **READ** to escape.

NOTE

Automatic meter actions that are configured to activate on a non-existent date are automatically changed to occur at the same time on the first day of the following month.

Example

An auto-billing period reset configured to occur at midnight on the 30th day of each month does so each month except February. In that instance, the BPR occurs at midnight on March 1st. A *day* is defined to begin at midnight (00:00:00 am) and end after 11:59:59.

Health Status

The meter has several internal safeguards that verify its' own operation. To check the status of these monitors:

- Select *Settings* > *Health Status* and choose a feature:
  - *Batt Status* - Monitors the internal RAM battery and advises if it is OK.
  - *Configuration* - Verifies if the meter's configuration is acceptable. This only checks for conflicts in the setup and individual settings could still be incorrect for your specific application.
  - *Site Monitor* - Indicates if the parameter, assigned as a Site Monitor in *JEMWare*, is Normal or in the Alarm state.
  - *Threshold 1/2/3/4* - Indicates if a monitored parameter, assigned as a Threshold Alarm in *JEMWare,* is Normal or in the Alarm state.

Interpreting Status Register Values in the *Ci20* Display

In addition to the Health Status display previously described, you can assign Normal or Alternate registers to report various status functions. This configuration procedure is fully described in the *JEMWare* software manual 1083-602.

Ci20 Status Register values appear as eight-digit hexadecimal numbers, although only three digit positions are applicable to status reporting. All other digits are zero and can be disregarded. The format of the displayed number is:

----MT-P

Where:

- *M* reports *Meter* status.
- *T* reports the *Threshold Alarm* status.
- *P* reports the *Potential Indicator* status.
- Digits in the – position are always zero.

Meter Status

Four conditions are reported in the Meter status digit:

Battery Warning — Occurs when the meter has spent more than a cumulative two years in a powered-down state, drawing battery power to maintain memory. This does NOT indicate that the battery is low, consider replacing it.

Configuration Default

Occurs when a non-recoverable error is detected in some part of the meter's Configuration tables, and the meter has switched that part to a default configuration.

Site Monitor Warning

Indicates that the meter has detected an alarm condition that the Site Monitor system was configured to report.

External Status Reports the state of the optional contact input, when the input is configured as a Status indicator. If both contact inputs are configured as Status, then an operation of either one (or both) produces the *On* indication.

Use Table 3.3 to interpret the hexadecimal code for *Meter* status, shown as the fifth digit from the left.

Table 3.3 Hexadecimal Code for Meter Status

Meter Status Digit Value	Battery Warning	Config Default	Site Monitor	External Status
0				
1				On
2			Yes	
3			Yes	On
4		Yes		
5		Yes		On
6		Yes	Yes	
7		Yes	Yes	On
8	Yes			
9	Yes			On
A	Yes		Yes	
B	Yes		Yes	On
C	Yes	Yes		

Table 3.3 Hexadecimal Code for Meter Status (Continued)

Meter Status Digit Value	Battery Warning	Config Default	Site Monitor	External Status
D	Yes	Yes		On
E	Yes	Yes	Yes	
F	Yes	Yes	Yes	On

Threshold Alarm Status

This digit, displayed sixth from the left, reports the state of the four Register Threshold detectors in the *Ci20* (Table 3.4).

Table 3.4 Register Threshold Detector Status

Threshold Alarm Digit Value	Threshold 1	Threshold 2	Threshold 3	Threshold 4
0				
1				Yes
2			Yes	
3			Yes	Yes
4		Yes		
5		Yes		Yes
6		Yes	Yes	
7		Yes	Yes	Yes
8	Yes			
9	Yes			Yes
A	Yes		Yes	
B	Yes		Yes	Yes
C	Yes	Yes		
D	Yes	Yes		Yes
E	Yes	Yes	Yes	
F	Yes	Yes	Yes	Yes

Potential Indicator Status

This digit, displayed eighth (or last) from the left, monitors the presence of up to three meter phase potential inputs (Table 3.5).

Table 3.5 Meter Phase Potential Monitor

Potential Indicator Digit Value	Phase C	Phase B	Phase A
0			
1			On
2		On	
3		On	On
4	On		
5	On		On
6	On	On	
7	On	On	On

Communication Settings

There are three basic methods of interfacing with *Ci20:* Optical port, Serial data (RS-232/485), and modem. The display menu allows reading and editing of basic communications port parameters such as:

Type	For Opt/S1 and Mod/S2, select whether communications are via RS232, RS485, or Modem
Address	Entered as a hexadecimal number
Baud rate	Use the arrow buttons to scroll through the available choices
Protocol	Use the arrow buttons to select either Binary, DNP, Modbus (RTU or ASCII), DPMS, TEC-870-102 or ANSI Tables
Go to menu	Select *Settings > Opti/S1* or *Mod/S2*, then choose one of the above parameters to read or edit.

Preset Meter Registers

Register Preset enables you to set meter registers at a predetermined value (Figure 3.6). This option is often used when meters are replaced, allowing you to set the new meter with the previous meter's register settings.

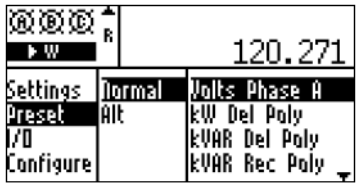


Figure 3.6 Preset Meter Registers

Most quantity registers can be preset. This function can be performed directly from the front panel of the meter, or with the *JEMWare* configuration software. Since this can affect the correlation between Register and Load Profile readings, this session is logged as a Register Preset event.

To preset the meter registers from the front panel:

1. Press any arrow key to enter the menu screen.
2. Using the arrow keys, go to menu selection *Preset* > *Normal* or *Alt*. The registers available for presetting appear in the far right column on the meter display.
3. Use the arrows to select a register from the right-hand column to preset, and then press **SET**. The first blinking digit in the setup field is the selected digit.
4. Increment the highlighted digit using the **+** or **-** button.
5. Press the right arrow button to select the next digit.
6. Continue selecting and incrementing/decrementing digits until the desired quantity appears.
7. When the desired register value is reached, press **Set** to save that register value. The meter automatically returns to the menu.
8. Repeat Steps 3 through 7 to preset any other register quantities.
9. When all the necessary registers are preset, press the left arrow button repeatedly to exit out of the menu screen, or press **READ**.

NOTE

Pressing the READ button while editing a register cancels the SET operation and restores the register to its' original value(s).

To preset the meter registers using *JEMWare* software, refer to the *JEMWare* Instruction Manual 1083-602

I/O Option

This is a view-only menu from the meter. All edits must be performed using *JEMWare* software. With the KYZ option for Contact Inputs installed, *Ci20* can accept up to two separate inputs from outside sources. Using *JEMWare* software, each input can be configured for one of the following:

- *Counter* - Used to count any pulses
- *Interval Sync* - Used to accept EOI output pulses from another meter, thus keeping demand intervals synchronized
- *TOU Override* - An input pulse causes the meter to revert to any predetermined Time Of Use rate.
- *Status* - An input pulse is recorded as a Status event in Load Profile data
- *Totalization* - An input pulse adds a configurable amount of energy to a Totalization channel's reading.

To view the input arrangement:

1. Select *I/O > Contacts*.
2. Select a *Channel* number for viewing. The screen displays how each of the two channels has been configured.

Configure

The Configure menus are used to put the meter in Test Mode, verify communications, check the meter installation using phasor diagrams, and perform a display pixel check.

4. Test & Calibration

Test Mode

You can test meter functions and accuracy from the front panel. Since this may temporarily inhibit registration, this session is logged as a Test Mode event.

Registration Adjustment

You can adjust the meter's Watt and VAR registration from the meter's front panel. This session is logged as a Calibration event and is performed in Test Mode. This is not a full meter calibration. If re-calibration is required, the meter must be returned to the factory.

The *Ci20* optical port on the face of the meter performs two functions. During Standard Meter Mode, it is used for serial communications. In Test Mode, the optical port on the face of the meter sends out test pulses consistent with the test register that is displayed (e.g. Watthour, Varhour). The pulse outputs are available even when the meter is in Test Mode, operating at their programmed K_e value. You can use a Scientific Columbus Model 5282 Optical Port Adapter or equivalent that converts the optical pulses to contact closures. This can then be interfaced to a Watt standard's, such as Scientific Columbus' MicroJoule®II, external gate input.

The *Ci20* is tested like any other electronic meter. Set it up so the test standard sees the same voltage and current as the meter. This is done by connecting the *Ci20* voltage elements in parallel and the current elements in series. Figure 4.1 shows how to connect a *Ci20* and a Watt Standard to an external load source.

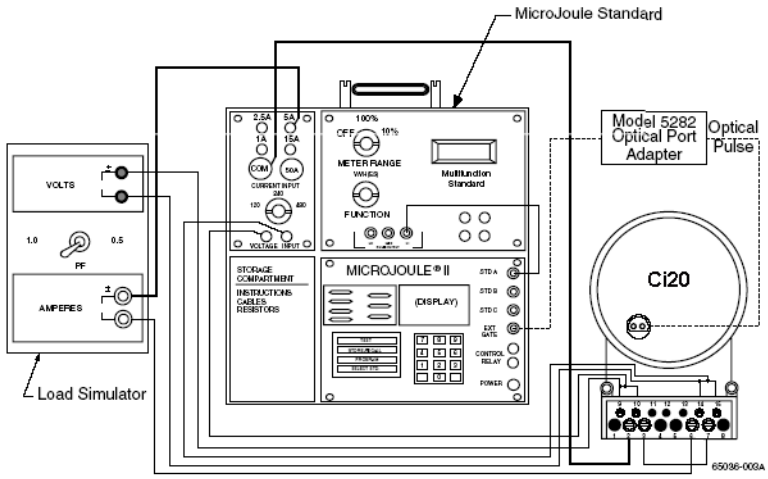


Figure 4.1 Typical Connection Diagram for Ci20 and Microjoule II to an External Load Source

The model number, serial number, firmware version, and calibration date are stored in nonvolatile memory and cannot be changed.

Test Mode

During Test Mode, the following conditions exist:

- Normal and Alternate registers stop accumulating. Peak, Coincident, and Time/Date of Peak registers may continue to update, but they behave as if there is zero power applied to the meter.
- Load Profile stops accumulating and storing interval records. Any partial interval counts accumulated before entering Test Mode is retained, and is stored with a Test Mode event record when Test Mode ends.
- Test Registers accumulate power, and behave as expected for the type of register. For example, Time-of-Use registers respond only during the correct rate period, Demand registers update on normal demand interval timing, etc.
- The Optical Port emits Test Pulses.
- Energy output pulses continue to operate as before.

Test Mode ends on any of these conditions:

- You manually leave Test Mode.
- The meter detects a period of inactivity and exits Test Mode automatically (*Test Mode timeout*).
- The meter loses power.

When Test Mode ends, the following occurs:

- Normal and Alternate registers resume normal operation, accumulating power that is applied to the meter. Demand and TOU scheduling is unaffected.
- Load Profile records a Test Mode event with partial interval counts from the interval before Test Mode began, then resumes normal operation.
- The Optical Test Pulse stops.

Enter Test Mode

To enter Test Mode, perform the following steps:

1. Press any arrow key to enter *Menu Mode*. A set of three list columns and a smaller numeric field appears.
2. Press the down arrow key three times to select *Configure*.
3. Press the right arrow key once to select *Tstmode*.
4. Press the right arrow key once more to enter *Test Mode*. *SET TO ENTER* appears.
5. Press *Set* to confirm entering *Test Mode*.

Exit Test Mode

To leave Test Mode:

1. Press the left arrow key from any Test register. *SET TO EXIT* appears.
2. Press **Set** to confirm leaving Test Mode.

NOTE

Pressing Reset while in Test Mode zeroes out all cumulative Test registers.

Navigating in Test Mode

To view a Test Register:

- Press the up or down arrow keys as needed to select the desired register. The content of the register appear in the numeric field above the menu lists.

To adjust the Watt / Watthour gain of the meter:

1. Select a Watt or Watthour Test register.

NOTE

Either one takes you to the combined Watt / Watthour gain adjustment. The adjustment affects both functions.

2. Press **Set**.

   The field above the menu lists shows a number such as *+0.00%*. The *+* sign is highlighted.

3. Toggle between *+* and - using the up or down arrow keys.
4. Select other digits to modify using the left and right arrow keys.
5. Increment/decrement each highlighted digit using the up or down arrow key. You can enter a percentage correction for Watt / Watthour registration between –9.99% and +9.99%.
6. Press **SET** to accept a value.

   The gain correction entered applies to both Watts and Watthours on *all* phases (delivered and received), even though the register displayed may have been a single-phase register.

   Watt / Watthour gain corrections entered in this way remain in effect after Test Mode ends.

NOTE

Adjusting Watt/Watthour gain affects VA, VAhour, Q, Qhour, and PF.

To adjust the VAR gain of the meter:

1. Select a VAR or VARhour Test register.

NOTE

Either one takes you to the combined VAR / VARhour gain adjustment. The adjustment affects both functions.

2. Press **Set**.

   The field above the menu lists shows a number such as *+0.00%*. The *+* sign is highlighted.

3. Toggle between *+* and - using the up or down arrow keys.
4. Select other digits to modify using the left and right arrow keys.

5. Increment/decrement each highlighted digit using the up or down arrow key. You can enter a percentage correction for VAR / VARhour registration between –9.99% and +9.99%.
6. Press **SET** to accept a value.

   The gain correction entered applies to both VARs and VARhours on *all* phases (delivered and received), even though the register displayed may have been a single-phase register.

   VAR / VARhour gain corrections entered in this way remains in effect after Test Mode ends.

NOTE

Adjusting VAR/VARhour gain affects VA, VAhour, Q, Qhour, and PF.

The Optical Test Pulse is an energy pulse output, similar to a KYZ pulse, that repeats at a rate proportional to energy consumption. Each pulse is a brief, approximately 30 to 40 millisecond, burst of infrared light sent by the Optical Port transmitter.

Measurements that can be selected for output as a Test Pulse are:

- Watthours
- VARhours
- Vahours
- Qhours
- Amphours

Any direction (Delivered, Received, per-quadrant) and element (phase A, B, C, or total) that can be selected for one of these measurements in a display register can be output as a Test Pulse. The pulse weight (Kt) for each pulse is fixed.

The Test Pulse output is always assigned to match the currently displayed Test register, if the register is displaying one of the measurements listed above. Table 4.1 discusses the display and output relationship.

Table 4.1 Register Display and Test Pulse Output

If the register displays:	The test pulse output is:
Watts or Watthours, per-phase or total, any direction	Watthours, per-phase or total, any direction, 1.8 Wh / pulse
VAR or VARhours, per-phase or total, any direction	VARhours, per-phase or total, any direction, 1.8 VARh / pulse
VA or VAhours, per-phase or total, any direction	VAhours, per-phase or total, any direction, 1.8 VAh / pulse

Table 4.1 Register Display and Test Pulse Output (Continued)

If the register displays:	The test pulse output is:
Q or Qhours, per-phase or total, any direction	Qhours, per-phase or total, any direction, 1.8 Qh / pulse
Amps or Amphours, per-phase or total	Amphours, per-phase or total, 0.02 Ah / pulse
Any other register type	No change from the previous Test Pulse assignment.

CAUTION

The Optical Test Pulse can be picked up with any Optical Port receiver, although we recommend the Scientific Columbus Model 5282 Optical Port Adapter. The 5282 allows the Optical Port to be used for serial communication with a computer as well as directing the Test Pulse to an external counter for accuracy testing.

If the Optical Port is being used for serial communication during Test Mode, a Test Pulse may occasionally interfere with the meter's response to commands. The meter *is* capable of receiving and executing commands during Test Mode – only the response may be garbled. The normal Binary Protocol error checking and retry mechanism provides reliable communication in this situation.

Ci20 Test Pulse Output

It is important to wait 15 seconds after application of potential before entering Test Mode. Otherwise, the meter may not produce test pulses in Test Mode. If the meter is suspected of not producing test pulses, scroll through Test Mode to the function under test - after 15 seconds of power-on time.

5. Maintenance

Any *Ci20* option, except for those noted as *factory configuration* or *configured at manufacture*, can be installed by a user with the following capabilities:

- Intermediate skill as an electronic technician, including knowledge of static-protection and electrical safety techniques.
- Familiar with the proper use of common tools (e.g. screwdrivers, wire strippers or cutters, wrenches, etc.) and equipment (e.g. Voltmeter) used in electronics, including static reduction equipment such as grounding straps or mats. Soldering equipment is NOT required.

The *Ci20* meter design, with its plug-together boards, requires few tools for maintenance.

CAUTION

All meter work must be performed at static-protected workstations WITH POWER REMOVED. The technician must follow properly prescribed static-control practices.
Refer to Appendix C "Electrostatic Discharge" for more information.

Ci20 Servicing

Ci20 meters are available in socket-base (S- and A-base mounting packages. The disassembly procedure for each type is described here.

Socket-base meters (S- and A-base)

Globe Removal

To perform this task:

1. Remove power from meter.
2. Remove all wire seals from the locking ring of the meter globe, and then remove the ring. You do NOT need to remove any seals from the RESET button.
3. Turn the globe counter-clockwise approximately 1 inch to disengage it from the base.
4. Carefully slide the globe forward away from the base and set it aside.

Internal Housing Disassembly

To perform this task:

1. Remove the top cover of the housing by unscrewing two Phillips-head screws (Figure 2.18).

2. Carefully lift the cover off, paying particular attention to the RAM battery wires. *Do not unplug the battery, or data is lost!*

Serviceable Parts

The *Ci20*'s communication board and I/O board can be changed in the meter shop with a few simple procedures. Because the register/metrology board is calibrated to the current transformers and power supply board, Ametek Power Instruments recommends that the meter be returned to the factory if changes to these components are necessary. Refer to "Board Removal/Installation" on page 2-28 for option board installation and configuration.

The *Ci20* clock/RAM battery is designed to last the life of the meter under normal storage and usage conditions. If the battery needs replacement, or you would like more information on any *Ci20* components, call Ametek Power Instruments' Technical Support staff at 800-950-5503.

Clock/RAM Battery

Ci20 contains an easily replaceable battery that is used to power the internal clock and RAM memory. The long life cell provides support for 10 years, and its life can be checked from the front panel display. There is also a display register (Days on Battery) that can be read to determine how many days the battery has been used. If the meter is in service, replace the battery while the meter is under power so that data is not lost (the battery is not used as long as service power is connected).

To replace the clock/RAM battery:

1. Remove the outer globe.

   The battery is the 1" high cylinder located at the top, right side of the meter.

2. Unplug the two-pin connector and lift the battery out of its holder.
3. Install a new, exact replacement battery, available from the factory. Specify part number 6005-254.
4. Select *Settings* > *Health* > *Batt Status* from the front panel menu, and then press the Set button until RESET appears.
5. Press the Set button and verify the display changes to BATTERY OK. The Date and Time may also need to be set if the meter was taken out of service while changing the battery.

Phone Home on Power Outage Battery Pack (Option)

Ci20 incorporates a replaceable battery pack that is used to power the internal Phone Home modem during power outages. The battery provides power to the modem for at least 8 hours of call time. It is recommended that the battery be changed every three years, or sooner if you experience numerous power outages.

To replace the Power Outage battery pack:

1. Remove power from the meter.
2. Ensure proper grounding.
3. Remove the outer globe.
4. On an S-based or A-base meter, remove the top cover. The battery pack is the four-cell assembly located in a holder directly under the cover. Unplug the two-pin connector and lift the battery up and out of its holder.
5. Install a new, exact replacement battery, available from the factory. Specify part number 15847-001.

Security Keys

Ci20 includes two security keys to protect the meter from tampering and unwanted access to certain meter functions. There are two removable jumpers (keys) located inside the meter on the Metrology board. One security key is used to disable all configuration changes from the front panel keypad menus, plus the following serial port commands when accessing the meter via *JEMWare*. Numbers in parentheses are the hex equivalent of the specific command in Ci20 binary (see Command Protocol manual 1086-384):

- Enter Test Mode (4D 01)
- Preset Normal Registers (57 01)
- Preset Alternate Registers (57 02)
- Configure Timekeeping (43 07)
- Configure Interval Timing (43 08) (demand and Load Profile intervals)
- Configure Demand Parameters (43 09) (subinterval length, outage deferral)
- Configure Load Profile (43 0A)
- Configure Pulse I/O (43 0B)
- Configure Primary Scaling (43 0D)
- Configure Normal display List (43 0E)

- Configure Alternate Display List (43 0F)
- Configure Test Display List (43 10)
- Configure TOU Schedules (43 12)
- Configure TOU Seasons (43 13)
- Configure TOU Holidays (43 14)
- Configure Reactive Selection (43 16)
- Configure Thermal Time Characteristic (43 18)
- Configure Threshold Alarms (43 19)
- Configure Site Monitor (43 1A)
- Configure DST Schedule (43 1C)
- Configure Energy Pulses (43 1D)
- Calibrating/Loading Flash Memory

The other key is used to disable just the meter's front panel RESET pushbutton. The RESET button is used to perform a Billing Period Reset (see the Glossary for definition). With the jumpers installed, access is enabled. Remove the jumpers to restrict access.

The meter is provided with both keys factory installed. If you want to remove the key(s) after proper configuration in your meter shop:

1. Remove power from the meter.
2. Remove the outer globe of the meter.
3. Remove the top cover of the housing by unscrewing three Phillips-head screws (Figure 2.18).
4. Carefully lift the cover off, paying particular attention to the RAM battery wires. *Do not unplug the battery, or data is lost!*
5. Remove the configuration access jumper and the RESET button jumper (Figure 5.1).

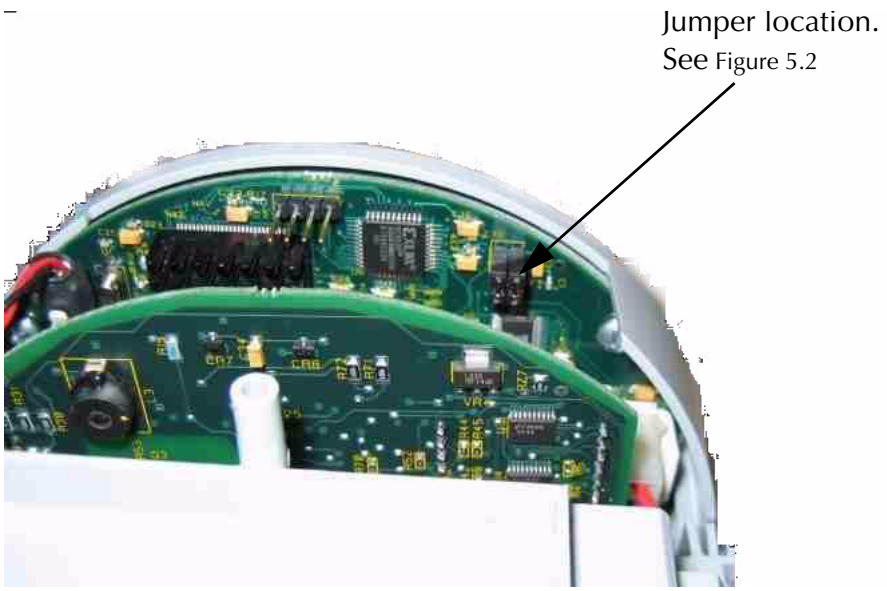


Figure 5.1 Rear View of Meter with Top Cover Removed

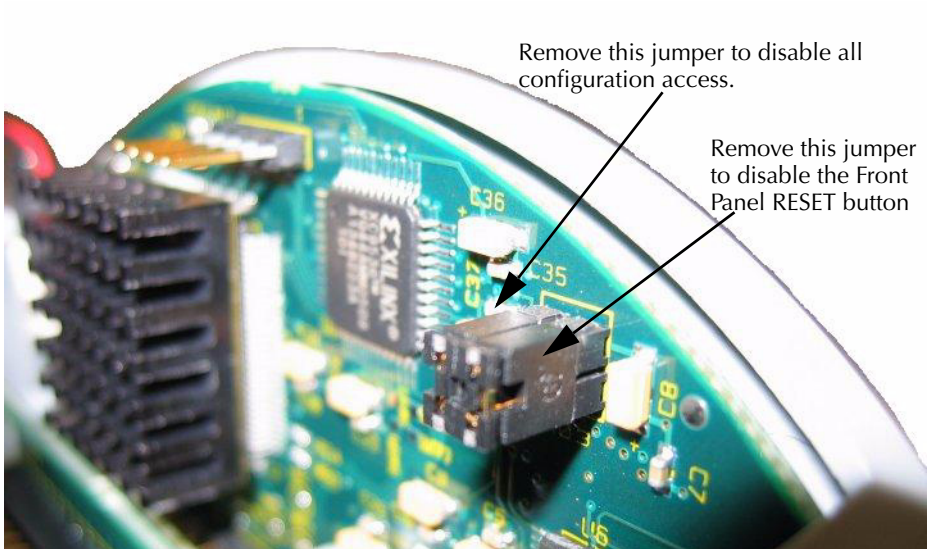


Figure 5.2 Security Jumper Location

The jumpers are a standard 0.1″ center, two-pin female shorting connector commonly used on most PC motherboards. Contact AMETEK and specify part number 4195-263, or ask your local computer shop for replacements.

NOTE

You can *park* the jumper in a disconnected position by just plugging it onto one contact. This keeps the jumper in the meter for future use.

Firmware Upgrades

New meter firmware can be downloaded remotely via the meter's serial port or modem (if equipped). This can be used to add optional features, product enhancements, or program upgrades. Contact the factory for more information and assistance.

Health Diagnostics

The *Ci20* health-status register provides an indication of the operating ability of the meter (Figure 5.3). This is one of the status registers that can be displayed in either of the registering display modes (Normal or Alternate). An *E* on the *Ci20*'s display indicates that a health condition is present and to open the health-status register.

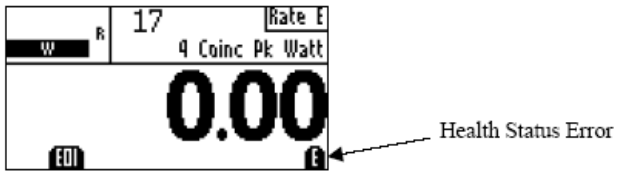


Figure 5.3 Ci20 Front Panel Display Health Status Error

If the *Ci20* meter ever has a health-status error, contact AMETEK for assistance in interpreting the situation.

Site Diagnostics

Ci20 can be configured to monitor its operating environment and report suspicious conditions. This monitoring occurs in two forms: Installation Verification and Installation Monitoring.

Installation (Site) Verification

Ci20 has an operating mode called Installation Verification, during which the meter makes and displays continuous readings of per-phase voltage, current, and their phase angles with respect to Volts Phase A. You enter this mode and read the information either from the front panel, or remotely via *JEMWare* software (Figure 5.4).

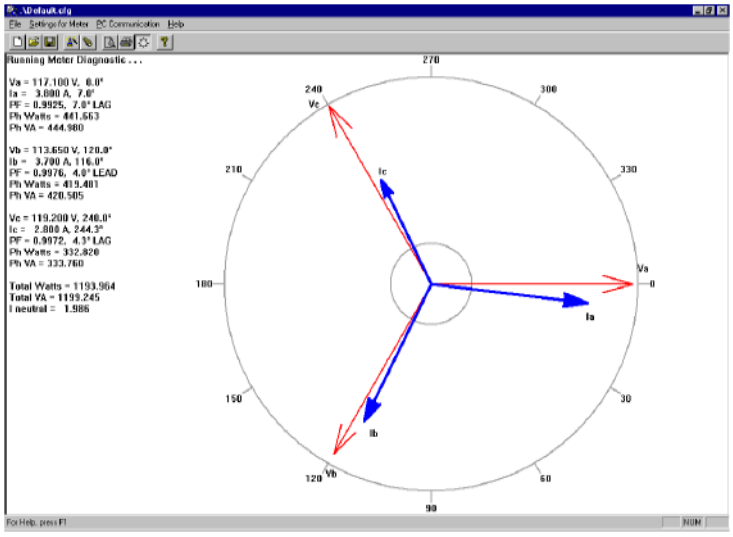


Figure 5.4 Diagnostic Display using JEMWare

Verification codes are used to interpret the information in light of the meter and service type. If the actual readings are inconsistent with the expected readings, the information suggests possible remedies.

6. Advanced Features

Time of Use

Ci20 maintains Time of Use (TOU) information for Consumption, Average PF, Peak Demand, Time of Peak Demand, Coincident Demand, and Coincident PF registers.

The meter can differentiate among up to 9 possible TOU rates, with registers for each rate, as configured by the user. *Ci20* can have up to 8 rate changes per day. Each rate change is configured for the time of the change (resolved to 1 minute) and the rate code (A – H, or Total). Midnight is always assumed to be a rate change. You must define the rate to begin at midnight of each day (midnight counts toward the limit of 8 changes per day).

Ci20 recognizes up to 9 day types per season: each day of the week (Sunday through Saturday) plus two Holiday types (Type 1 and Type 2). A rate change schedule must be defined for each day type.

A given day is recognized as a particular day of the week based on the *Ci20* internal clock and calendar, unless that date is listed in the Holiday List. Any date in the Holiday List must be identified as a Type 1 or Type 2 Holiday. *Ci20* can store up to 200 holidays in the Holiday List.

Ci20 is configurable for up to 4 season changes per year. The date (month, day, and year) of each season start, along with an indication of the season (Season 1, Season 2, Season 3, or Season 4) that starts on that date, is stored in the Season List. The Season List holds up to 80 Season Start dates (4 per year for 20 years).

Ci20 can be configured to force the present TOU rate in effect to any other programmed rate by triggering a contact closure input. You must select a rate (1-8, or Total) to switch to when a closure is detected on the input. The rate then reverts to the normal scheduled rate when the contact opens.

To configure a meter for Time of Use functions, consult the *JEMWare* instruction manual 1083-602.

Load Profile

Ci20 can record up to 4 Load Profile channels as a standard feature, or up to 12 channels as an added option. All Load Profile configurations are performed using *JEMWare* software. Load Profile storage is such that if the available memory becomes full, the oldest record(s) are deleted from memory to make room for the most recent. *Ci20* stores one single record at the end of each Load Profile interval. A Load Profile interval may end on any of the following conditions:

- On the hour (if configured for *internal Load Profile synchronization*) and each multiple of the configured Load Profile interval length after the hour. Load Profile intervals can be configured to be 1, 5, 10, 15, 20, 30, or 60 minutes in length.
- On any time set, Daylight Saving Time adjustment, recognizable power outage, or other event that would cause a discontinuity in interval timing.
- On any event that may cause a discontinuity in registration so that register readings and equivalent Load Profile readings could not be reconciled. (E.g. Register Freeze, Billing Period Reset, Register Preset, etc.)

The Load Profile intervals resemble demand intervals, but can be set independently. The interval closures occur on even increments within the hour. For example, a 15-minute interval begins on the hour and closes at 00:15; the next interval closes at 00:30; the next interval closes at 00:45; etc. At the end of each interval, the meter records the number of pulses accumulated since the last Load Profile interval closure or special event. When the Load Profile data storage memory is full, the meter overwrites the oldest information. The number of days of storage available is determined by the Load Profile interval length and number of channels stored.

Each Load Profile interval contains one or more channels of data. Each channel is configurable as to the quantity to be recorded, and the equivalent pulse constant (Km). Each channel can store up to 16,000 equivalent counts per interval.

Ci20 stores at least 60 days of data for 4 channels (up to 12 channels available) recorded every 5 minutes, along with all included Midnight records and reasonable numbers of Time Set, Billing Period Reset, and Power Outage intervals. By configuring fewer channels and/or longer intervals, you can increase the number of days of storage.
Each Load Profile channel can be configured to record one of the following:

- Any consumption quantity
- The number of pulses received in an interval on a contact closure input. Both make and break transitions are counted in the total.
- State of a contact input over the interval. If the contact was closed one or more times during the interval, the channel records 1 count, otherwise zero.
- The average of any Instantaneous quantities over a Load Profile interval. In this case, the channel pulse count multiplied by the equivalent pulse constant shall give the average value, NOT the consumption in unit-hours, for the Load Profile interval.
- Accumulation in a Totalization channel.

  For example, for a 3-element meter operating at 120 Volts, 5 Amps, 1.0 PF on every element, an equivalent pulse constant of 1.0 on all channels, and 15 minute Load Profile intervals, the Watthour Delivered channel reports 450 counts (120V x 5A x 3 elements / 4 intervals per hour). The Average Instantaneous Watt Delivered channel reports 1800.

Table 6.1 Approximate Number of Days of Load Profile Storage (12-Channel Option)

Interval Length (minutes)	Number of Load Profile Channels Used											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1	49	24	16	12	9	8	7	6	5	4	4	4
2	98	49	32	24	19	16	14	12	10	9	8	8
3	147	73	49	36	29	24	21	18	16	14	13	12
4	196	98	65	49	39	32	28	24	21	19	17	16
5	245	122	81	61	49	40	35	30	27	24	22	20
6	294	147	98	73	58	49	42	36	32	29	26	24
10	490	245	163	122	98	81	70	61	54	49	44	40
12	588	294	196	147	117	98	84	73	65	58	53	49
15	736	368	245	184	147	122	105	92	81	73	66	61
20	981	490	327	245	196	163	140	122	109	98	89	81
30	1472	736	490	368	294	245	210	184	163	147	133	122
60	2944	1472	981	736	588	490	420	368	327	294	267	245

Table 6.2 Approximate Number of Days of Load Profile Storage (4-Channel Standard)

Interval Length (minutes)	Number of Load Profile Channels Used			
	1	**2**	**3**	**4**
1	17	8	5	4
2	34	17	11	8
3	51	25	17	12
4	68	34	22	17
5	85	42	28	21
6	102	51	34	25
10	170	85	56	42
12	204	102	68	51
15	256	128	85	64
20	341	170	113	85
30	512	256	170	128
60	1024	512	341	256

Ci20 records certain events in the Load Profile system intermixed with regular interval data. Any event that would end a Load Profile interval is recorded, including the following:

Power Fail — Indicates that the meter has lost auxiliary power. If the meter does not have separate auxiliary power, Power Fail indicates the loss of Phase A power. The time of power failure and time of restoration are recorded.

Time Set — The beginning and end of a time set are recorded in load-profile memory. Time set can be performed at the meter or by use of serial communications.

Daylight-Saving Time — Adjustment events are stored. Changes are programmed via the *JEMWare* program. The DST change start and stop times are recorded.

Test Mode	Entries and exits are recorded as events. No load-profile data is recorded during the Test Mode. Test Mode can be initiated at the meter or through serial communications.
Configuration Event	A configuration event is stored in the load-profile memory. Load-profile data is erased when any load-profile-related parameter is configured. The configuration event is executed only through serial communications.
Freeze Event	A freeze event causes the meter to take a snapshot of the Normal- and Alternate-Mode registers. When the meter reads these registers via serial communications, the value stored at the time of the most recent freeze event is returned. This event is executed only via serial commands.
Demand Reset	Indicates the time of storage-register updates and register clearing. This command can be initiated from the meter or through serial communications.
Register Preset	Indicates the time of storage-register presetting when used. This command can be initiated from the meter or through serial communications.
Midnight	Indicates when midnight occurs in the Load Profile sequence of events.

All recorded events include the following information:

- The date and time at which the event occurred
- A description of the type of event
- The counts for each configured channel from the beginning of the interval until the event occurred
- If applicable, the time at which the event ended (such as for a Time Set or power outage).

Load-Profile Retrieval

Load Profile can be retrieved in any of the following segments:

- All complete Load Profile records in memory, oldest first.
- All complete Load Profile records since the last Load Profile read, oldest first.
- All Load Profile records for the last N days, for N = 0 through 60. For any number of days requested, the meter sends that number of complete day's records plus whatever records have been stored in the current day.

  For example, requesting 0 days gives only today's records since midnight. Requesting 2 days gives all records for the preceding 2 days plus the present day's records. If the Load Profile memory does not contain enough days of records to fulfill the request, the meter sends all records presently stored.

Data can be retrieved with Ametek Power Instruments' *JEMRead* software or by Itron's MV-90 software. Connection to the meter can be via the optical port, RS-232 / RS-485 serial port, or a modem.

The command protocol specifications that defines the data transfer method is public domain and can be obtained from the factory; ask for Publication 1086-384. Ametek Power Instruments recommends that only experienced programmers fluent in communication interfaces undertake such a task.

External-Synchronized Load-Profile Interval Closures

External interval tracking in the meter affects the load-profile channels. For that reason, load-profile interval length must match demand-interval length.

When configured for external synchronization, the meter uses two time sources—one for determining interval closure and one for the meter's real-time clock. Data skewing is possible if a synchronization pulse occurs on the load-profile interval boundary.

External Control of Load Profile Recording

Ci20 can be optionally configured to only record Load Profile data during externally triggered periods. This can be user-selected on a per channel basis, which means that some channels can record constantly, and some can record upon command from an external source. *JEMWare* can be used to configure any Load Profile channel to record when the TOU Rate Override contact input is ON.

To configure this operation in *JEMWare*:

1. Go to the Load Profile menu and either Add a new LP channel, or highlight an existing one to Edit.

2. In the setup screen, choose *Records During TOU Override Only*. Choose **OK**.
3. Go to the Contact Input/Output menu and set one of the two Input channels for *TOU Rate Override*.
4. Apply a signal to the Contact Input to begin LP recording on the designated channel.

NOTES

The TOU Rate Override input does not affect interval timing in any way. It only gates the collection of measurements in configured Load Profile channels.

Load Profile channels configured to record only during TOU Rate Override are not associated with a given TOU rate. For example: If the meter is configured to use Rate C as the TOU Override rate, and Rate C also appears in the normal TOU schedule, the selected Load Profile channels record only while the TOU Rate Override input is on.

Average Instantaneous Load Profile channels that are configured for TOU Rate Override are averaged over the period that the TOU Rate Override input is on. For example, with a constant 1000 Watts applied to the meter and an Average Instantaneous Watt load profile channel, if the TOU Rate Override input is active for one half of an interval the final value recorded in that interval is 1000 Watts, not 500 Watts. If the TOU Rate Override input stays off for the entire interval, the channel is record 0. (An exception to this is Average Power Factor, which resets to 1.0 at the beginning of an interval and remains there unless some actual measurements are collected.)

Table 6.3 Typical Load Profile Printout

==========							
Load Profile Data Display							
==========							
No.	Event Type	Date	Time	-1-	-2-	-3-	-4-
851	Data	11-20-00	13:15:00	0	0	0	0

Table 6.3 Typical Load Profile Printout

852	Data	11-20-00	13:20:00	0	0	0	0
853	Data	11-20-00	13:25:00	20	0	25	0
854	Test Mode	11-20-00	13:25:36	5	0	5	0
855	Test Mode End	11-20-00	13:26:13				
856	Time Set	11-20-00	13:28:55	19	0	24	0
857	Time Set End	11-20-00	23:54:52				
858	Data	11-20-00	23:55:00	1	0	1	0
859	Midnight	11-21-00	00:00:00	37	0	47	0
860	Data	11-21-00	00:05:00	42	0	52	0
861	Test Mode	11-21-00	00:08:02	26	0	32	0
862	Test Mode End	11-21-00	00:10:53				
863	Data	11-21-00	00:15:00	29	0	37	0
864	Power Failure	11-21-00	00:15:52	6	0	7	0
865	Power Failure End	11-21-00	00:17:14				
866	Data	11-21-00	00:20:00	19	0	24	0
867	Data	11-21-00	00:25:00	35	0	44	0

Table 6.3 Typical Load Profile Printout

868	Data	11-21-00	00:30:00	35	0	44	0
869	Data	11-21-00	00:35:00	36	0	44	0
870	Data	11-21-00	00:40:00	35	0	43	0
871	Billing Reset	11-21-00	00:40:51	6	0	8	0
872	Data	11-21-00	00:45:00	29	0	36	0
873	LP Download	11-21-00	00:45:08				

Demand Prediction

Ci20 can be purchased with an optional feature that displays a Demand Prediction for any measured Peak Demand quantity. This includes Watts delivered or received; VARs delivered, received, or per-quadrant; VA delivered or received; Q delivered or received; Amps; or Amps Squared.

A Demand Prediction is the Demand value that is expected at the end of the present demand interval. For example, if a level 1000 Watts is applied to the meter for a demand interval, the *predicted* demand at any time during that interval is 1000 Watts (See Example 1). At the end of the demand interval, the *actual* demand (which is based on actual measurements, not expected measurements) is 1000 Watts.

Ci20 updates its internal Demand Prediction approximately every 50 milliseconds. Displayed Demand Predictions respond more slowly due to system and display timing constraints. Each update is based on the average of actual instantaneous readings taken in the current demand interval multiplied by the demand interval time that has already passed, plus the most recent instantaneous reading multiplied by the time remaining in the demand interval.

The result of this process is that a Demand Prediction register displays what the Demand is at the end of the interval *if the load remains constant at its present value* until then. If the load does vary, the Demand Prediction register reflects the new prediction and update the display within a second.

Demand Predictions can be used to monitor a load in order to prevent setting a new Peak Demand. If a Demand Prediction register shows a value that is higher than the existing Peak Demand, then a new Peak occurs at the end of the demand interval unless the load is reduced.

In the case of a sliding window (also known as rolling) demand, predictions are made in the last subinterval of the demand interval. In other words, *Ci20* does not try to predict the demand beyond the present subinterval.

Demand Prediction Algorithm

The calculation is performed at a rate of once every three power line cycles (about 50 ms):

$$PredDmd = \frac{((Avg \times Sec) + (Press \times Rem))}{Int}$$

Where:

- PredDmd = Demand Prediction
- Avg = Average of Instantaneous Readings already taken in the present demand interval. The average is updated just before the Prediction is made.
- Sec = Seconds that have already elapsed in the demand interval
- Pres = Most recent Instantaneous Reading
- Rem = Seconds remaining in Demand Interval
- Int = Total number of seconds in Demand Interval

Examples

Graphs are not to scale. Assume one Instantaneous measurement per minute for illustration purposes.

Example 1: Predicted demand with level load (Figure 6.1)

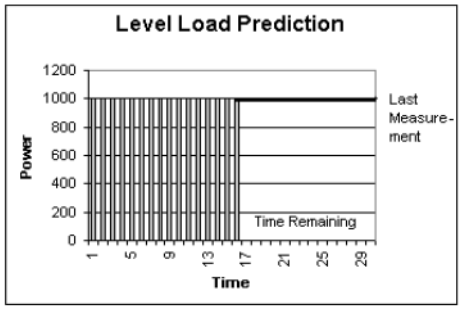


Figure 6.1 Level Load Prediction

At 16 minutes into the demand interval, every measurement was 1000 Watts, which means the average power was also 1000 Watts. One thousand Watts times 16 minutes = 16,000 Watt-minutes.

The most recent Instantaneous measurement (taken at 16 minutes into the interval) is 1000 Watts. Assume the average power of the remaining 14 (of 30) measurements is 1000 Watts. (I.e. a level load.) One thousand Watts times 14 minutes = 14,000 Watt-minutes. Added to the 16,000 Watt-minutes from before, the total is 30,000 Watt-minutes. Divided by 30 total minutes, the Predicted Demand is 1000 Watts.

Example 2: Predicted demand with varying load (Figure 6.2)

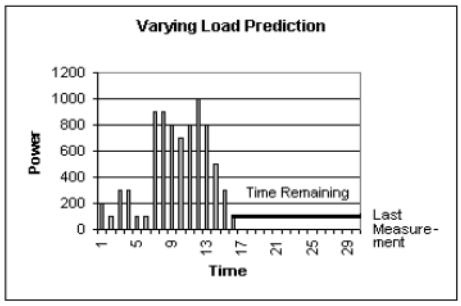


Figure 6.2 Varying Load Prediction

At 16 minutes into the demand interval the average of 16 Instantaneous measurements was 493.75 Watts. That average times 16 minutes equals 7900 Watt-minutes.

The most recent Instantaneous measurement (taken at 16 minutes into the interval) is 100 Watts. Assume the average power of the remaining 14 (of 30) measurements is 100 Watts. (I.e. a level load.) One hundred Watts times 14 minutes = 1400 Watt-minutes. Added to the 7900 Watt-minutes from before, the total is 9300 Watt-minutes. Divided by 30 total minutes, the Predicted Demand is 310 Watts.

Example 3: Predicted demand with varying load – further update (Figure 6.3)

Continuing in the same demand interval from Example 2: At 25 minutes into the demand interval the average of 25 Instantaneous measurements was 576 Watts. That average times 25 minutes equals 14,400 Watt-minutes.

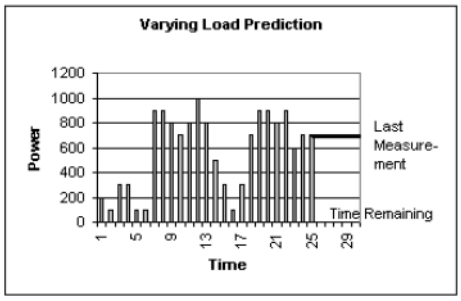


Figure 6.3 Varying Load Prediction

The most recent Instantaneous measurement (taken at 25 minutes into the interval) is 700 Watts. Assume the average power of the remaining 5 (of 30) measurements is 100 Watts. (I.e. a level load.) Seven hundred Watts times 5 minutes = 3500 Watt-minutes. Added to the 14,400 Watt-minutes from before, the total is 17,900 Watt-minutes. Divided by 30 total minutes, the Predicted Demand is 596.67 Watts.

Voltage and Current Transformer Gain Correction

The *Ci20* meter can be adjusted to compensate for gain errors in external voltage and current circuitry; for example, ratio errors in external voltage or current transformers. This correction can be done without tampering with the actual meter calibration as established at the factory, or any local meter calibration adjustments made in Test Mode.

Transformer gain correction is set in *JEMWare* from the Primary Configuration screen. The user can enter a gain correction from -10.00% to +10.00% in 0.01% increments for each voltage and current input. These corrections are applied directly to measured voltages and currents before any further computation is performed; therefore they affect virtually all quantities in the meter.

Like the Test Mode calibration adjustments, the transformer gain correction is lost if a Cold Start or Firmware Upgrade is performed. Unlike the Test Mode calibration adjustment, the transformer gain correction is stored as part of a *JEMWare* configuration file. Therefore, it is important to check the gain correction figures whenever a configuration file is shared among several meters.

Changing the gain of a voltage or current input causes any single-phase measurement using that input to increase or decrease by the amount of the change. For example, changing the Phase A Volts by +1.00% causes all Phase A measurements to read 1% high (except for Amp quantities).

Polyphase measurements changes by the average of the changes made to each individual phase. For example, if Phase A Volts is changed by +1.00%, Phase B Volts by +2.00% and Phase C Volts by +4.00%, the change to polyphase Watts is (1+2+4)/3=2.333%

Voltage Sag / Swell Detection and Log

The *Ci20* meter can be purchased with an optional Voltage Sag and Swell detection and logging system. The Sag / Swell detector compares the RMS voltage of each cycle on each meter voltage input against user-configured upper and lower limits. Whenever a voltage crosses one of these limits an event is detected. If the event lasts longer than the user-specified minimum duration, it is recorded in the Sag / Swell Event Log.

The user must configure the following settings for the Sag / Swell Detector:

- Lower voltage (sag) limit for each phase voltage (A, B, and C)*. Voltages below this limit are detected as a sag event.
- Upper voltage (swell) limit for each phase voltage (A, B, and C) *. Voltages above this limit are detected as a swell event.
- Minimum duration of event (in cycles) to log. Events shorter than this duration are not logged. A single duration limit is applied to all phases for both sag and swell events.
- Enhanced resolution mode. This mode allows the ability to measure swell voltages and currents significantly higher than those normally encountered in the circuit at the expense of accurate power measurement at light loads.

* On 2- and 2 ½ element meters the B phase voltage is ignored.

In normal operation, the Ci20 adjusts its voltage and current input gain circuits to maximize power and energy measurement accuracy. A sudden increase in voltage (a swell) or current (such as that associated with a fault that causes a voltage sag) may temporarily overload the meter's inputs, causing clipped voltage and current readings and inaccurate measurements. The enhanced resolution mode causes the meter to run at lower gain, allowing accurate capture of voltage swells (up to 100% above nominal Volts) and current (up to the rated input of the meter) at the expense of seriously reduced power and energy accuracy, especially at light loads.

NOTE

Do not use enhanced resolution mode unless you are willing to accept poor accuracy in your power and energy measurements. In enhanced resolution mode, all power measurements are made at accuracies listed in Chapter 1 "General Information".

The single-cycle RMS voltages and currents measured by the Sag / Swell detection system operate at an accuracy of 1% of reading regardless of the setting of the enhanced resolution mode.

The Sag / Swell Event Log records measurements of interest to engineers researching power quality issues. Each event records the following information:

For each of 3 phases:

- Maximum voltage
- Minimum voltage
- Average voltage
- Maximum current
- Minimum current
- Average current
- Average PF

For the entire event:

- Time at which it occurred or began (resolved to 1 second)
- Duration of the event in cycles
- Status (event type and phase) of the event

The Sag / Swell event system can detect and log voltage sags or swells on each phase that are up to 600 cycles in length as a single event. Sags or swells that exceed that length are logged as two events: the first records the time at which the sag or swell began and the voltages and currents associated with its first 600 cycles. The second logged event records the time at which the sag or swell ended and an indication that it is the end of a long event. The possible Status codes are therefore:

Events up to 600 cycles in length:

- Volts A sag
- Volts B sag
- Volts C sag
- Volts A swell
- Volts B swell
- Volts C swell

Events longer than 600 cycles:

- Volts A long sag
- Volts B long sag
- Volts C long sag
- Volts A long swell
- Volts B long swell
- Volts C long swell

End of long events:

- Volts A long sag end
- Volts B long sag end
- Volts C long sag end
- Volts A long swell end
- Volts B long swell end
- Volts C long swell end

Totalization

The *Ci20* meter can be purchased with an optional Totalization system. Totalization is ability to sum the energy readings from several different instruments and display the result. *Ci20* has 12 totalization channels. Each channel can be displayed as a register in the Normal, Alternate, or Test lists and / or recorded as a Load Profile channel.

Each Totalization channel behaves as a Consumption register with several added features. Details on how to configure Totalization channels are contained in the *JEMWare* User Manual, (document 1083-602). For each channel the user must configure the following:

- Measurement quantity: choice of Watthours, VARhours, VAhours, Qhours, Amphours, Volt Squared hours, Amp Squared hours* or Zero (which accumulates only external energy)
- Phase: A, B, C, or Polyphase*
- Direction: Delivered, Received, or a single quadrant for VARhours*
- Time of Use Rate: A through H or Total*
- Compensated or Uncompensated*
- Test Mode
- Enabled
- Load Profile Km in Primary (i.e. at VT and CT input) units
- Up to 6 external energy inputs (contact inputs)
- Pulse Weight in Primary units for each external energy input. Negative pulse weights are deducted from the Totalization channel's reading, but it never falls below zero.

* These settings are identical to those of a Consumption register.

Most of these settings are self-explanatory, but a few require further description.

The Test Mode setting causes the Totalization channel to operate only while the meter is in Test Mode. If a Totalization register is to be displayed in the meter's Test list, it must have the Test Mode selection enabled.

Enabled means the Totalization channel is active.

Load Profile Km is the pulse weight of counts recorded in Load Profile if a Profile channel is selected to record this Totalization channel's contents. This bypasses the normal Load Profile pulse constant configuration for that channel.

External energy inputs are pulse inputs on the *Ci20* configured to be Totalization inputs. Any transition (make or break) on one of these inputs can be detected by any Totalization channel and cause that channel to add the associated Pulse Weight to the Totalization's contents. that input Pulse Weights are configured independently for each Totalization channel. For example, Totalization Channel 1 may count each transition on input one as 1.0 MWh, while Totalization Channel 2 may count each transition on input one as -3.8 MWh.

A Totalization channel can be displayed, recorded as a Load Profile channel, or both. To display a Totalization channel, add a register to the desired Display List (Normal, Alternate, or Test) in *JEMWare* with a Category of *Totalization* and select the desired Totalization channel number in the Type field. You can then set up the number of digits and decimal places, storage type, and label as for any other numeric register.

To record a Totalization channel in Load Profile, add a Profile channel in *JEMWare*. In the Quantity field select the desired Totalization channel number. The Km, Direction, and Phase settings are bypassed, but you can still select whether to record always or only during TOU Rate Override.

NOTE

Normally Load Profile channels can not be associated with Time of Use rates other than Total. However, you can simulate a Load Profile channel that records only during a given rate period by assigning it to a Totalization channel with the correct rate. The Totalization channel need not record any external energy, making it essentially identical to an integrated Load Profile channel.

Site Monitoring

Site Monitoring is used to continuously monitor the site conditions and provide notifications when they exceed pre-set limits.

A Site Monitor Alarm indicates power line anomalies associated with the voltage, current or power factor of each power line phase. You can select any or all phase(s) and specify one or more conditions on each phase to trigger an alarm. There is only one Site Monitor alarm output. If you set multiple conditions, any one of the conditions activates the alarm. JEMWare allows you to query the meter to determine the condition that caused the alarm

Table 6.4 Site Monitor Alarm Settings Per Phase

Individually Selected Per Phase Measurements (in primary units)	
Over Voltage	This setting will trigger a Site Monitor Alarm when the Phase Voltage exceeds the over voltage setting. It will return to normal when it drops below the setting.
Under Voltage	This setting will trigger a Site Monitor Alarm when the Phase Voltage drops below the under voltage setting. It will return to normal when it rises above the setting.
Voltage Rise	This setting works in conjunction with the voltage rise/dip duration setting in seconds. This will trigger a Site Monitor Alarm when the Phase Voltage exceeds the voltage rise setting for the duration (in seconds) selected. It will return to normal when it drops below the setting.
Voltage Dip	This setting works in conjunction with the voltage rise/dip duration setting in seconds. This will trigger a Site Monitor Alarm when the Phase Voltage drops below the voltage dip setting for the duration (in seconds) selected. It will return to normal when it rises above the setting.
Over Current	This setting will trigger a Site Monitor Alarm when the Phase Current exceeds the over current setting. It will return to normal when it drops below the setting.
Under Current	This setting will trigger a Site Monitor Alarm when the Phase Current drops below the under current setting. It will return to normal when it rises above the setting.
Power Factor High	This setting will trigger a Site Monitor Alarm when the Phase Power Factor exceeds the power factor high setting. It will return to normal when it drops below the setting.

Table 6.4 Site Monitor Alarm Settings Per Phase

Individually Selected Per Phase Measurements (in primary units)	
Power Factor Low	This setting will trigger a Site Monitor Alarm when the Phase Power Factor drops below the power factor low setting. It will return to normal when it rises above the setting.
Power Reversed	This checkbox will trigger a Site Monitor Alarm whenever the power goes negative. It will return to normal when the power flow is positive.

Table 6.5 Site Monitor Alarm Settings System

System Measurements (in primary units)	
Neutral Current Swell	This setting works in conjunction with the voltage rise/dip duration setting in seconds. This will trigger a Site Monitor Alarm when the neutral current exceeds the neutral current swell setting for the duration (in seconds) selected. It will return to normal when it drops below the setting.
Neutral Over Current	This setting will trigger a Site Monitor Alarm when the Neutral Current exceeds the neutral current setting. It will return to normal when it drops below the setting.
Voltages out of Sequence	This checkbox will trigger a Site Monitor Alarm whenever it detects a phase voltage out of sequence. For example, if the meter detects the phase direction ACB instead of ABC expected, it will trigger an alarm and will return to normal when it is in the correct sequence.
Volts Imbalance	Volts imbalance will trigger a Site Monitor Alarm whenever an individual phase varies by the percent setting as compared to the average of the other phases. It will return to normal whenever the volts imbalance in % drops below the setting.
Amps Imbalance	Amps imbalance will trigger a Site Monitor Alarm whenever an individual phase varies by the percent setting as compared to the average of the other phases. It will return to normal whenever the Amps imbalance in % drops below the setting.

NOTE

The per phase selections above are available for Site Monitoring regardless if the Per Phase Measurement option is enabled.

Each site monitor test can be disabled or enabled during meter configuration. Any detected anomaly can be configured to report any combination of the following local or remote notifications:

Table 6.6 Site Monitor Alarm Remote Reporting

Remote Notification	
Alarm Contact Output	Close a Site Monitor Alarm contact output on the Ci20 (if the I/O option is purchased). The contact output remains closed until the detected condition has gone away.
Modem Dial Out	Dial out any of 4 specified phone numbers and report the alarm via text message. The text message will indicate which meter called, the time the call was initiated, and the event(s) that occurred. (Note: The Internal Modem option is required.)
Modbus, DNP, Binary	Report the Site Monitor Alarm via the communication outputs (Modbus, DNP, Binary) if enabled. Note: All individual alarm settings are reported via the communication outputs. Example: Phase A Voltage Dip will be reported.
JEMWare, JEMRead	The Site Monitor Alarm and all individual settings can be displayed via JEMWare or JEMRead software. (if supplied) The event log can also be saved or printed.

Table 6.7 Site Monitor Alarm Local Notification

Local Notification	
Event Log	Log to an event buffer, with the date and time when the condition was detected. For example, 07:52:00 07/07/2005 Over Voltage Phase A. If later on the condition is detected to have cleared, another event shall be logged noting the date and time.
Health Status	Set an indication in the Health Status summary register. This indication is removed when the detected condition has gone away. It can also be latched until a Billing Period Reset is performed.
Display Indicator	Activate an annunciator on the front panel. This indication is removed when the detected condition has gone away. It can also be latched until a Billing Period Reset is performed.

Anomalies are reported only when first detected; persistent conditions are not re-reported unless they have cleared first. A Billing Period Reset clears any latched anomaly reports that are no longer valid

Alarm Thresholds

A Threshold Alarm indicates when a user-selected storage register exceeds predetermined limits. Any predefined display register can be used to trigger an alarm (time & date are not valid registers for alarms). This is ideal for reporting when a consumption register is reaching a predefined limit or when a peak demand exceeds a predefined rate.

There are four Threshold Alarms available, but you can only monitor one register with each. For every Threshold Alarm, you can configure the Alarm and Reset values. The Reset Value must be lower than the Alarm Value, since this is a high threshold alarm. If there is a need to provide a low threshold alarm (for power factor, negative watts, etc.), configure the Reset setting as the Alarm and Alarm as the Reset Setting. You can configure the alarm output to close or open to alarm as needed for your application.

The Threshold Alarms can be configured to report any combination of the following local or remote notifications:

Table 6.8 Alarm Thresholds Remote

Remote Notification	
Alarm Contact Output	Close or open a Threshold Alarm contact output on the Ci20 (if the I/O option is purchased). Each Alarm Threshold can be assigned to it's own relay output.
Modem Dial Out	Dial out any of 4 specified phone numbers and report each alarm threshold individually or together as a group via text message. The text message will indicate which meter called, the time the call was initiated, and the event(s) that occurred. (Note: The Internal Modem option is required.)
Modbus, DNP, Binary	Report the Threshold Alarm via the communication outputs (Modbus, DNP, Binary) if enabled. Note: Each individual alarm threshold is reported via the communication outputs.
JEMWare, JEMRead	The Site Monitor Alarm and all individual settings can be displayed via JEMWare or JEMRead software. (if supplied) The event log can also be saved or printed.

Table 6.9 Alarm Thresholds Local

Local Notification	
Event Log	Log to an event buffer, with the date and time when the condition was detected. For example, 07:52:00 07/24/2005 Alarm Threshold 1.If later on the condition is detected to have cleared, another event shall be logged noting the date and time.
Health Status	Set an indication in the Health Status summary register. This indication is removed when the detected condition has gone away. It can also be latched until a Billing Period Reset is performed.
Display Indicator	Each individual alarm threshold can indicate an annunciator on the meter display. This indication follows the active polarity of the contact setting. (closed indicates alarm, open is normal) It can also be latched until a Billing Period Reset is performed.

Appendix A. *Ci20* Default Settings

The following is a list of the factory default settings that are seen in a *Ci20* meter after a cold start is performed. Use *JEMWare* software to program the meter with your custom configuration.

Meter Identification

ID String 1	(meter name)
ID String 2	(administrator)
ID String 3	(location)
ID String 4	(config id)
ID String 5	(acct number)
ID Label 1	Meter Name
ID Label 2	Administrator
ID Label 3	Location
ID Label 4	Config ID
ID Label 5	Acct Number

Primary Configuration

Nominal Voltage	120V
Connection Type	4-Wire Y
Reactive Power Unit	VAR
VT Ratio	120:120
CT Ratio	5:5
Register Scaling:	

- Watt, VA - Units
- VAR, Q - Units
- Volt - Volts
- Amp - Amps

Display Registers

Table A.1 Normal Registers

Num	Type	Qty	Dir	Phase	Display	Rate	Digits	Decimal	Label
000	ID								Ci20
001	Time				Working				Present Time
002	Date				Working				Present Date
003	Consumption	W Hr	Del	Poly	Working	Total	6	3	KWatthour Delivered
004	Consumption	W Hr	Rec	Poly	Working	Total	6	3	KWatthour Received
005	Consumption	VAR Hr	Del	Poly	Working	Total	6	3	KVARhour Delivered
006	Consumption	VAR Hr	Rec	Poly	Working	Total	6	3	KVARhour Received
007	Peak Demand	Watts		Poly	Working	Total	6	3	PkD,W:P,DE,T,WK

Table A.2 Alternate Registers

Num	Type	Qty	Dir	Phase	Display	Rate	Digits	Decimal	Label
100	Time of Peak Demand	Time			Working				TPkD,Time:,,,WK
101	Date of Peak Demand	Date			Working				TPkD,Date:,,,WK
102	Consumption	W Hr	Del	Poly	BPR	Total	6	3	Cons,WH:P,DE,T,BP
103	Consumption	W Hr	Rec	Poly	BPR	Total	6	3	Cons,WH:P,RE,T,BP
104	Consumption	VAR Hr	Del	Poly	BPR	Total	6	3	Cons,VARH:P,DE,T,BP
105	Consumption	VAR Hr	Rec	Poly	BPR	Total	6	3	Cons,VARH:P,RE,T,BP
106	Vector Dislay			IaIbIc	Working				IaIbIc Vector

Table A.3 Test Registers

Num	Type	Qty	Dir	Phase	Disp	Rate	Digits	Decimal	Label
201	Consumpt	Watt	Del	Poly	Working	Total	6	3	kWh Del Poly T
202	Consumpt	Watt	Rec	Poly	Working	Total	6	3	kWh Rec Poly T
203	Consumpt	VAR	Del	Poly	Working	Total	6	3	kVARh Del Poly T
204	Consumpt	VAR	Rec	Poly	Working	Total	6	3	kVARh Rec Poly T
205	Consumpt	VA	Del	Poly	Working	Total	6	3	kVAh Del Poly T
206	Consumpt	VA	Rec	Poly	Working	Total	6	3	kVAh Rec Poly T
207	Consumpt	Q	Del	Poly	Working	Total	6	3	KQh Del Poly T
208	Consumpt	Q	Rec	Poly	Working	Total	6	3	KQh Rec Poly T
209	Consumpt	Amp		Poly	Working	Total	6	3	Amph Poly T
210	Instant	Watt	Del	Poly	Working		6	1	Inst kW Del Poly T
211	Time	Test			Working				Test Time Remaining

Load Profile

Interval Length	15 Minutes
Number of Channels	4 (can be extended to 12)
Interval Sync	Internal
Freeze Markers	Enabled
Channel 1	Watthours delivered, polyphase, .00001 Wh/count
Channel 2	Watthours received polyphase, .00001 Wh/count
Channel 3	VARhours delivered, polyphase, .00001 VARh/count
Channel 4	VARhours received, polyphase, .00001 VARh/count

Time of Use Setup

No Seasons or Time of Use schedules configured

No Override Rate

No Holidays schedules

Timekeeping and DST Changes

Meter Clock Sync	Internal
Auto Register Freeze	none
Auto Billing Period Reset	none
DST dates	none

Alarms

Site Monitor Alarms	none assigned
Threshold 1	none assigned
Threshold 2	none assigned
Threshold 3	none assigned
Threshold 4	none assigned

Contact Input / Output

Channel 1	none assigned
Channel 2	none assigned
Channel 3	none assigned
Channel 4	none assigned
Channel 5	none assigned
Channel 6	none assigned

Demands

Interval length	15 minutes
Subinterval length	15 minutes
Deferral intervals	1 subinterval
Power Outage	Recognition after 8 seconds
Interval Sync	Internal
Thermal Time Characteristic	15 Minute

Serial Communication

Optical /Serial 1	RS232 9600 baud Protocol: Ci20 Binary Address: 01 Password timeout: 5 min. TX start delay: 40mS (RS-232); 80mS (RS-485) TX end delay: 0mS (RS-232); 20mS (RS-485) Turnaround delay: 80mS
Serial 2	RS232 9600 baud Protocol : Ci20 Binary Address: 02 Password timeout: 5 min. TX start delay: 40mS (RS-232); 80mS (RS-485) TX end delay: 80mS (RS-232); 20mS (RS-485) Turnaround delay: 80mS
Modem	9600 baud (Internal modem has a maximum connection speed of 2400 baud) Protocol: Ci20 Binary Address: 03 Password timeout: 10 min. Initialization String: ATH Modem answer schedule: • Frequency: daily • Start time:00:00 • Duration: 60 minutes • # of rings to answer: 2 • # of rings to answer after delay: 3 Modem Phone Home settings: none Modem Power Fail Phone Home settings: none

Ethernet	DHCP: Not selected
	IP Address: 0.0.0.0
	Subnet Mask: 0.0.0.0
	Default Gateway: 0.0.0.0
	IP Port #: 2000
	Max Connections: 4
	Device Address: 04
	Protocol: Ci20 Binary

Display Setup

Preset mode timeout: 1 minutes

Test Mode timeout: 30 minutes

Demand Reset lockout: 5 minutes

Display's Number of Digits: 6 (leading blanks)

Scroll rate: 5 seconds

Date Format: MM/DD/YY

Threshold 1 alarm action: Annunciator

Threshold 2 alarm action: Annunciator

Threshold 3 alarm action: Annunciator

Threshold 4 alarm action: Annunciator

Site Monitor action: Annunciator

Passwords / Permissions

Master Password permissions are always *all*

Password 2 permissions: none

Password 3 permissions: none

Password 4 permissions: none

All passwords

- Master password set to 000000 (6 zeros)
- Password 2 set to 111111 (six ones)
- Password 3 set to 222222 (six twos)
- Password 4 set to 333333 (six threes)

Sag / Swell Detection

Voltage Swell (all phases): 530

Voltage Sag (all phases): 0

Minimum Duration: 1 line cycle

Maximize voltage swell/over-current resolutionnot selected

Totalization

Measurement Quantity: Zero (none selected)

Totalization Channels 1-6: None selected

Load Profile Km: 0

Internal Modem Initialization Commands

Modes of Operation

The Xecom™ modem uses *AT* commands for control and configuration. The XE1414B operates in two modes:

- Command Mode
- Data Mode

Extensions to the AT command set support fax operation.

Data Mode — The modem enters data mode after it establishes a link and issues a *CONNECT* result code.

In Data Mode the modem modulates all signals on Transmit Data, Pin 13, and sends them to the remote modem. The modem demodulates the signal from the remote modem and places it onto Received Data, Pin 3, for the host equipment. When the modem exits data mode, it issues a *NO CARRIER* result code.

Command Mode — The modem enters command mode on application of power, reset, loss of the connection, or receipt of the escape sequence. In command mode the modem accepts commands from the host on Transmit Data. Appropriate result codes are returned on Received Data at the same speed and parity as the commands.

Commands

NOTE

The command set for the Xecom modem is listed for reference only. The Ci20 may not support all commands as listed, such as: Receive HDLC Data, Baud Rates over 2,400, Fax Mode, etc.

The modem is configured and controlled with AT commands. AT commands follow a strict format. The command line is stored in the command buffer and executed upon receipt of a carriage return. Until executed, the command line can be edited with the backspace key.

Command Format

Each command, except A/, begins with the AT prefix. The *A* and *T* can be both upper case or both lower case but cannot be of different cases. The modem uses the prefix to identify the host's speed and parity. The modem determines speed by measuring the width of the incoming bits and parity by comparing the parity bits of the *A* and *T*. The modem then returns result codes at the host's speed and parity.

Command Line

A command line can include multiple commands. The modem executes the commands in the sequence they appear in the command line. Spaces, inserted to improve legibility, do not fill space in the command buffer. A carriage return terminates the command line and causes the commands to be executed.

Register S3 allows you to select a character other than a carriage return to terminate the command line.

Command Buffer

The command buffer holds 40 characters, including the AT prefix. If it overflows, the modem issues an *ERROR* result code and commands are not executed.

Command Line Editing

A backspace can be used to edit the command any time before it is executed. The backspace character, Control and H simultaneously on some systems, erases the previous character in the command line. Any character except for the *A* and *T* can be erased. Register S5 allows you to select a character other than a backspace to edit the command line.

Re-Execute Last Command

The A/ command causes the modem to re-execute the command line stored in the command buffer. This is the only command that does not require the *AT* prefix.

Omitted Parameters	Most commands include a parameter which determines the command function. When the parameter is omitted from the command string, it is assumed to be a 0.
Escape Characters	A three character escape sequence, entered while in data mode, switches the modem into command mode while remaining on-line. The escape character, set by Register S2, is entered three times in succession to execute the escape. The default escape sequence is *+++*.
Result Codes	The modem issues a result code after each action. Result codes can be provided as full words, numeric codes or can be disabled. Each result code ends with a carriage return when numeric result codes are chosen. When full word result codes are chosen, a Line Feed and Carriage Return precede and follow each result code.

List of Commands

An asterisk indicates the default setting of the command for the XE1414B:

A - Answer Command

ATA forces the modem to immediately go off-hook and begin transmitting the answer tone sequence.

Bn - Select Communications Standard

ATBn selects the modulation scheme used for connections below 2400 bits per second:

- n=0 - Selects CCITT standards
- n=1 - Selects Bell standards*

D - Dial Command

Below are the characters accepted in a dialing command:

- 0-9, #, * = Dialing Digits
- L = Redial last number
- P = Pulse dial
- T = Tone dial
- S=n = Dial stored number
- W = Wait for dial tone
- ^ = Toggles state of calling tone
- , = Pause for the duration of S8
- @ = Wait for silence
- ! = Switch hook flash
- ; = Return to the command state

En - Command Echo

ATEn determines whether commands is echoed back to the host:

- n=0 - Do not echo commands
- n=1 - Enable command echo*

Hn - Switch Hook Control

ATHn opens and closes the modem's hook switch:

- n=0 - Switch hook relay opens
- n=1 - The switch hook relay closes

In - Modem Identification

ATIn Identifies the version of the modem.

Ln - Speaker Volume

ATLn sets the amplitude of the modem's audio output:

- n=0 - Lowest speaker volume
- n=1 - Low speaker volume*
- n=2 - Moderate speaker volume
- n=3 - High speaker volume

Mn - Speaker Activity

ATMn determines when the modem's audio output is active:

- n=0 - Speaker off
- n=1 - Speaker on until carrier received*
- n=2 - Speaker remains on
- n=3 - Speaker off during dialing, on until carrier

Nn - Data Rate

ATNn selects whether or not the modem negotiates a lower data link speed:

- n=0 - Handshake only at DTE rate
- n=1 - Negotiate highest common speed*

On - On Line

ATOn switches the modem from the command mode to the data mode:

- n=0 - Return On Line with no retrain*
- n=1 - Initiate retrain returning On Line.

Qn - Responses

ATQn determines if the modem issues responses:

- n=0 - Send responses*
- n=1 - No Responses

Sr? - Interrogate Register

ATSr? requests the current value in register Sr.

Sr=n - Set Register Value

ATsr=n sets the value of register Sr to n.

Vn - Result Codes

ATVn sets the modem to issue Numeric or Full Word result codes:

- n=0 - Numeric Result Codes
- n=1 - English Word Result Codes*

Wn - Connect Message Rate

ATWn determines whether the data rate reported in the Connect response is the host data rate, the link data rate or whether both are provided along with the error control and data compression protocols negotiated:

- n=0 - Send CONNECT at DTE Rate*
- n=1 - Report line speed, DTE speed and Link protocol
- n=2 - CONNECT Reports Link speed

Xn - Result Code Set

ATXn selects which set of result codes the modem sends:

- n=0 - Result codes 0 to 4
- n=1 - Result codes 0 to 5 and 10
- n=2 - Result codes 0 to 6 and 10
- n=3 - Result codes 0 to 5, 7 and 10
- n=4 - Full Result codes*

Yn - Long Space Disconnect

ATYn determines if the modem automatically disconnects if a continuous space is received for 1.6 seconds:

- n=0 - Long Space Disconnect Disabled*
- n=1 - Disconnect on long space

Zn - Reset

ATZn executes a soft reset to the modem and resets the modem configuration:

- n=0 - Reset to user profile 0*
- n=1 - Reset to user profile 1

&Cn - DCD Operation

AT&Cn determines the operation of the DCD output:

- n=0 - DCD is forced active.
- n=1 - DCD indicates a valid carrier*

&Dn - DTR

AT&Dn determines how the modem responds to changes to DTR:

- n=0 - DTR is ignored by the modem.
- n=1 - Enter command mode if DTR revoked.
- n=2 - Disconnect if DTR revoked.*
- n=3 - Soft reset when DTR revoked

&Fn - Return to Factory Defaults

AT&Fn returns the modem configuration to one of two factory configurations:

- n=0 - Restore configuration 0*
- n=1 - Restore configuration 1

&Gn - Guard Tone

AT&Gn controls the guard tone produced by the modem:

- n=0 - Guard Tone Disabled*
- n=1 - Guard Tone Disabled
- n=2 -1800 Hz Guard Tone

&Kn - Flow Control

AT&Kn selects the flow control method used by the modem:

- n=0 - Disabled
- n=3 - RTS/CTS
- n=4 - XON/XOFF
- n=5 - Transparent XON/XOFF
- n=6 - RTS/CTS and XON/XOFF

&Pn - Dial Pulse Make/Break Ratio

AT&Pn determines the specific pulse dialing parameters used by the modem:

- n=0 - 39/61% @ 10 pps*
- n=1 - 33/67% @ 10 pps
- n=2 - 39/61% @ 20 pps

&Qn - Line Connection

AT&Qn determines if error control or data buffering are active on the link:

- n=0 - Direct mode (no data buffering)*
- n=5 - Use Error Correction
- n=6 - Normal Mode (Speed buffering)

&Sn - DSR Operation

AT&Sn sets the operation of the DSR signal:

- n=0 - DSR always active*
- n=1 - DSR in accordance with V.25.

&Tn - Test Modes

AT&T selects modem test modes:

- n=0 - Exit test mode
- n=1 - Local analog loopback
- n=3 - Initiate local digital loopback
- n=4 - Respond to remote loop request*
- n=5 - Deny remote loop request
- n=6 - Initiate a Remote Digital loopback
- n=7 - Remote digital loopback w self-test
- n=8 - Local analog loopback w self-test

&Vn - View Configuration Profiles

AT&V permits you to check on the modem's current configuration:

- n=0 - View active profile & user profile 0*
- n=1 - View active profile & user profile 1

&Wn - Store Active Profile

AT&Wn stores the current modem configuration in NVRAM:

- n=0 - Store active profile as profile 0*
- n=1 - Store active profile as profile 1

&Yn - Recall Stored Profile

AT&Yn sets the stored modem configuration for use after a hard reset:

- n=0 - Recall profile 0 on power-up*
- n=1 - Recall profile 1 on power-up
- &Zn=x - Store telephone number x in memory location n

%En - Line Quality Monitor/Auto Retrain

AT%En determines if the modem monitors line quality during a connection and initiates a retrain if quality drops below acceptable levels:

- n=0 - Disabled
- n=1 - Enabled
- n=2 - Line quality, fallback, fall forward
- n=3 - 33/67% @ 20 pps

%L - Read Received Signal Level

AT%L permits you to read the magnitude of the receive signal in dBm.

%Q - Read Line Signal Quality

AT%Q permits you to read the EQM value of the received signal.

\An - MNP Block Size

AT|An sets the block size for MNP data packets:

- n=0 - Maximum 64 characters
- n=1 - Maximum 128 characters
- n=2 - Maximum 192 characters
- n=3 - Maximum 256 characters*

\Bn - Transmit Break

AT\Bn selects the duration of the break signal sent. Break = n x 100 msec.

\Gn - Modem Port Flow Control

- n=0 - No Modem Port Flow Control
- n=1 - XON/XOFF Port Flow Control

\Kn - Break control

AT\Kn determines how the modem handles a break signal.

Break received from host with Reliable link:

- n=0 - Enter on-line command mode; do not transmit break
- n=1 - Purge buffers, immediately transmit break
- n=2 - Same as n=0
- n=3 - Immediately send break
- n=4 - Same as n=0
- n=5 - Send break in sequence with data*

Break received from host with Direct link:

- n=0 - Immediately transmit break, then enter on-line command mode
- n=1 - Immediately send break
- n=2 - Enter command mode but do not transmit break signal
- n=3 - Same as n=1
- n=4 - Same as n=0
- n=5 - Same as n=1*

Break received from modem Normal link:

- n=0 - Purge buffers, Immediately send break to the host
- n=1 - Same as n=0
- n=2 - Immediately send break to the host
- n=3 - Same as n=2
- n=4 - Send break in sequence with data.
- n=5 - Same as n=2*

Host initiates break with \B command on Reliablelink:

- n=0 - Purge buffers and immediately transmit break
- n=1 - Same as n=0
- n=2 - Immediately transmit break
- n=3 - Same as n=1
- n=4 - Transmit break in sequence w data
- n=5 - Same as n=4

\Nn - Error Control Selection

AT\Nn determines how the modem handles error control negotiations:

- n=0 - Normal mode, no error correction
- n=1 - Direct mode, no buffering, no error correction
- n=2 - Reliable mode, error correction required for connection
- n=3 - V.42 Auto-reliable mode, accept either an error controlled or non-error controlled link*
- n=4 - V.42 Reliable mode, LAPM required
- n=5 - MNP required

-Kn - MNP Extended Services

AT-Kn determines how the modem handles MNP10:

- n=0 - No LAPM to MNP10 conversion
- n=1 - LAPM to MNP10 conversion*
- n=2 - LAPM to MNP10 conversion but no MNP Extended Service during V.42 LAPM answer mode detect.

S0 Answer on nth Ring

S0 sets the modem to automatically answer on the nth ring. Setting S0 to 0 disables automatic answer:

- Range - 0 to 255
- Units - Rings
- Default - 0

S1 Ring Count

S1 is a read-only register showing the number of rings detected. If a ring is not detected within eight seconds, S1 is reset to zero:

- Range - 0 to 255
- Units - Rings
- Default - 0

S2 Escape Character

S2 determines the ASCII escape character. Values of 0-127 select valid ASCII escape characters. Values from 128 to 255 disable the escape sequence:

- Range - 0 to 255
- Units - ASCII Character
- Default - 43 (+)

S3 Carriage Return Character

S3 determines the ASCII character to serve as a carriage return to terminate commands and modem responses:

- Range - 0 to 127
- Units - ASCII Character
- Default - 13 (Carriage Return)

S4 Line Feed Character

S4 sets the ASCII character to act as a line feed character in modem responses:

- Range - 0 to 127
- Units - ASCII Character
- Default - 10 (Line Feed)

S5 Back Space Character

S5 defines the ASCII character used as a backspace to edit the command line:

- Range - 0 to 32
- Units - ASCII Character
- Default - 8 (Back Space)

S6 Dial Tone Wait Time

S6 determines how long the modem waits for dial tone before dialing begins. The Dial Tone Wait Time cannot be set to less than two seconds:

- Range - 2 to 255
- Units - Seconds
- Default - 2

S7 Wait for Carrier after Dialing

S7 determines how long the modem waits for a valid carrier signal after dialing is complete:

- Range - 1 to 255
- Units - Seconds
- Default - 50

S8 Comma Pause Time

S8 defines the duration of the pause initiated by a comma in the dialing string. The pause is generally used when waiting for a second dial tone:

- Range - 1 to 255
- Units - Seconds
- Default -50

S9 Carrier Detect Response Time

S9 establishes the length of time the remote modem's carrier must be present to be recognized as valid:

- Range - 1 to 255
- Units - 0.1 Seconds
- Default - 6

S10 Carrier Off Disconnect Delay

S10 selects how long carrier must be lost before the modem disconnects. If S10 is smaller than the value of S9, the modem does not automatically disconnect on loss of carrier:

- Range - 1 to 255
- Units - 0.1 Seconds
- Default - 14

S11 Tone Dialing Speed

S10 sets the duration and spacing of the dialing tones. S11 does not affect the pulse dialing rate:

- Range - 50 to 255
- Units - 1 Millisecond
- Default - 95

S12 Escape Code Guard Timer

S12 sets the escape sequence guard timer. If characters are received before or after the escape sequence, within the guard timer, the modem aborts the escape attempt and remains in data mode:

- Range - 0 to 255
- Units - 0.02 Seconds
- Default - 50

S14 General Bit-Mapped Options

S14 reflects the state of several AT commands.

- Bit 0,4,6- Not Used
- Bit 1:
  - 0 = Echo Disabled (ATE0)
  - 1 = Echo Active (ATE1)
- Bit 2:
  - 0 = Send Result Codes (ATQ0)
  - 1 = No Result Codes (ATQ1)
- Bit 3:
  - 0 = Numeric Result Codes (ATV0)
  - 1 = Full Word Result Codes (ATV1)
- Bit 5:
  - 0 = Tone Dialing Selected (T)
  - 1 = Pulse Dialing Selected (P)
- Bit 7:
  - 0 = Answer
  - 1 = Originate

S16 Test Status

S16 shows the modem test status:

- Bit 0:
  - 0 = No Local Analog Loopback
  - 1 = Local ALB Active
- Bit 1 - Not Used
- Bit 2:
  - 0 = Local Digital Loopback Disabled
  - 1 = Local DLB Enabled
- Bit 3:
  - 0 = No Remote Digital Loopback
  - 1 = Remote DLB Active
- Bit 4:
  - 0 = Remote DLB not requested
  - 1 = Remote DLB Requested
- Bit 5:
  - 0 = Remote DLB w Self-Test Disabled
  - 1 = Remote DLB w Self-Test Enabled
- Bit 6:
  - 0 = Local ALB w Self-Test Disabled
  - 1 = Local ALB w Self-Test Enabled
- Bit 7 - Not Used

S18 Test Timer

S18 sets the duration of any test. If S18 equals 0, AT&T0 terminates the test:

- Range - 0 to 255
- Units - Seconds
- Default - 0

S21 General Bit-Mapped Options

S21 reflects the state of several AT commands:

- Bit 0-2 - Not Used
- Bit 3,4 - 0 = DTR ignored (&D0)
  - 1 = Enter command mode on DTR off (&D1)
  - 2 = Disconnect on DTR off (&D2)
  - 3 = Reset on DTR off (&D3)
- Bit 5:
  - 0 = DCD always active (&C0)
  - 1 = DCD on with Carrier (&C1)

S22 General Bit-Mapped Options

S22 reflects the state of several AT commands:

- Bit 0-1:
  - 0 = Low speaker volume (ATL0)
  - 1 = Low speaker volume (ATL1
  - 2 = Moderate speaker volume (ATL2)
  - 3 = High speaker volume (ATL3)
- Bit 2-3:
  - 0 = Speaker off (ATM0)
  - 1 = Speaker off with carrier (ATM1)
  - 2 = Speaker always on (ATM2)
  - 3 = Speaker on during handshake (ATM3)
- Bit 4-6:
  - 0 = Basic Result codes (ATX0)
  - 4 = Connect speed result codes (ATX1
  - 5 = No Blind Dial (ATX2)
  - 6 = Busy Detection (ATX3)
  - 7 = Full result codes (ATX4)
- Bit 7 - Not Used

S23 General Bit-Mapped Options

S23 reflects the state of several AT commands:

- Bit 0:
  - 0 = Remote DLB Disabled (AT&T5)
  - 1 = Remote DLB Allowed (AT&T4)
- Bit 1-3:
  - 0 = Host Interface at 300 bps
  - 1 = Host Interface at 600 bps
  - 2 = Host Interface at 1200 bps
  - 3 = Host Interface at 2400 bps
  - 4 = Host Interface at 4800 bps
  - 5 = Host Interface at 9600 bps
  - 6 = Host Interface at 19200 bps
  - 7 = Host I/F at 38400 bps or higher
- Bit 4-5:
  - 0 = Even parity in use
  - 1 = Not used
  - 2 = Odd Parity in use
  - 3 = No Parity in use
- Bit 6-7:
  - 0 = No Guard Tone (AT&G0)
  - 1 = No Guard Tone (AT&G1)
  - 2 = 1800 Hz guard tone (AT&G2)
  - 3 = Not Used

S27 General Bit-Mapped Options

S27 reflects the state of several AT commands:

- Bit:
  - 0 1 3
  - 0 0 0 = Normal Mode (AT&Q0)
  - 1 0 1 = Error control enabled (AT&Q5)
  - 0 1 1 = Direct Mode (AT&Q6)
- Bit 2, 4-5, 7 - Not Used
- Bit 6:
  - 0 = CCITT Protocols (ATB0)
  - 1 = Bell Protocols (ATB1)

S28 Pulse Dialing Bit-Mapped Options

S28 stores the modem's pulse dialing configuration:

- Bit 0-2, 5-7 - Not Used
- Bit 3-4:
  - 0 = Make/Break ratio 39%/61%; 10 pulses per second (AT&P0)
  - 1 = Make/Break ratio 33%/67%; 10 pulses per second (AT&P1)
  - 2 = Make/Break ratio 39%/61%; 20 pulses per second (AT&P2)
  - 3 = Make/Break ratio 33%/67%; 20 pulses per second (AT&P3)

S29 Hook Flash Timer

S29 determines the length for time the modem closes its off-hook relay on receipt of the ! dial modifier to simulate a switch hook flash:

- Range - 0 to 255
- Units - 10 milliseconds
- Default - 70

S30 Disconnect on Inactivity Timer

S30 sets the period and the modem is idle before it disconnects. A 0 disables the inactivity timer:

- Range: - 0 to 255
- Units - 10 Seconds
- Default - 0

S31 General Bit-Mapped Options

S31 stores the status of various AT commands:

- Bit 0:
  - 0 = No single-line Connect messages (AT\V0)
  - 1 = Use single-line connect messages (AT\V1)
- Bit 1:
  - 0 = No Automode detection (ATN0)
  - 1 = Automode detection active (ATN1)
- Bit 2-3:
  - 0 = Report host speed (ATW0)
  - 1 = Report all parameters (ATW1)
  - 2 = Report modem speed only (ATW2)
- Bit 4-7 - Not Used

S32 XON Character

S32 determines the ASCII character sent as XON for in-band flow control:

- Range - 0 to 255
- Units - ASCII Character
- Default - 11 (VT)

S33 XOFF Character

S32 determines the ASCII character recognized as XOFF for in-band flow control:

- Range - 0 to 255
- Units - ASCII Character
- Default - 19 (DC3)

S36 LAPM Failure

S36 instructs the modem what to do if the error control negotiations fail:

- Bit 0-2:
  - 0 = Modem Disconnects
  - 1 = Establish Direct Connection
  - 3 = Establish normal Connection
  - 4 = Disconnect if MNP handshake fails
  - 5 = Establish Direct Connection if MNP handshake fails.
  - 7 = Establish Normal Connection if MNP handshake fails.
- Bit 3-7 - Not Used

S38 Forced Disconnect Timer

S38 sets the delay between receipt of the command to disconnect and the actual opening of the switch hook. If S38 is set to 255, the modem disconnects only after its buffers are empty.

- Range - 0 to 255
- Units - 1 Second
- Default - 20

S39 Flow Control Bit-Mapped Options

S39 shows the modem's flow control status, AT&K:

- Bit 0-2:
  - 0 = Flow Control Disabled
  - 3 = Hardware Flow Control, RTS/CTS
  - 4 = In-Band Flow Control XON/XOFF
  - 5 = Transparent In-Band Flow Control
  - 6 = Both Hardware and In-Band Flow Control
- Bit 3-7 - Not used

S40 MNP Bit-Mapped Options

S40 shows the status of the modem's MNP commands:

- Bit 0-1:
  - 0 = No LAPM to MNP10 conversion (AT-K0)
  - 1 = Enable LAPM to MNP10 conversion (AT-K1)
  - 2 = Enable LAPM to MNP10 conversion except for LAPM answer mode (AT-K1)
- Bit 2 - Not Used
- Bit 3-5:
  - 0 = AT\K0 break handling selected
  - 1 = AT\K1 break handling selected
  - 2 = AT\K2 break handling selected
  - 3 = AT\K3 break handling selected
  - 4 = AT\K4 break handling selected
  - 5 = AT\K5 break handling selected
- Bit 6-7:
  - 0 = MNP Block size 64 characters
  - 1 = MNP Block size 128 characters
  - 2 = MNP Block size 192 characters
  - 3 = MNP Block size 256 characters

S41 General Bit-Mapped Options

S41 stores the condition of various AT commands:

- Bit 0-1:
  - 0 = No Data Compression (AT%C0)
  - 1 = MNP5 Data Compression (AT&C1)
  - 2 = V.42bis Data Compression (AT&C2)
  - 3 = Either MNP5 or V.42bis Data Compression (AT&C3)
- Bit 2, 6:
  - 0 0 = No Fallback/Forward (AT%E0)
  - 1 0 = Retrain Enabled (AT%E1)
  - 0 0 = Fallback/Forward Enabled (AT%E2)
- Bit 3-5, 7 - Not Used

S46 Data Compression Control

S46 selects whether or not the modem supports data compression with error control:

- S46=136 - No data compression
- S46=138 - Data Compression selected
- Default -38

S48 V.42 Negotiations

S48 determines the modem's V.42 negotiation process:

- S48=0 - Proceed with LAPM
- S48=7 - Negotiate per V.42
- S48=128 - Assume LAPM failure
- Default - 7

S86 Call Failure Code

S86 shows why the last NO CARRIER response was issued:

- S86=0 - Normal Disconnect
- S86=4 - Loss of Carrier
- S86=5 - V.42 Negotiation Failure
- S86=9 - Modem Handshake Failure
- S86=12 - Disconnect Initiated by remote modem
- S86=13 - No response after 10 retries
- S86=14 - Protocol Violation

S95 Extended Result Codes

S95 permits you to customize the extended result codes:

- Bit 0 - Connect result code shows link speed
- Bit 1 - Add /ARQ to connect response
- Bit 2 - Add /VFC to Carrier response
- Bit 3 - Enable Protocol response
- Bit 4 - Not Used
- Bit 5 - Enable Compression Result Code
- Bit 6 - Not used
- Bit 7 - Not Used

AT+FCLASS? - Service Class Indication

- 0 = Configured as a data modem
- 1 = Configured for Service Class 1.

AT+FCLASS=? - Service Class Capability

- 0 = Configured as a data modem
- 1 = Configured for Service Class 1.

AT+FCLASS=n - Set Service Class

- 0 = Configured as a data modem
- 1 = Configured for Service Class 1.

AT+FAE=n - Data/Fax Auto Answer

- 0 = Answer as a fax modem only
- 1 = Either a fax or data modem

AT+FF - Enhanced Flow Control

AT+FRH<mod> - Receive HDLC Data

- 3 - V.21 Channel 2, 300 bps
- 24 - V.27ter, 2400 bps
- 48 - V.27ter, 4800 bps
- 72 - V.29, 7200 bps
- 96 - V.29, 9600 bps
- 97 - V.17, 9600 bps
- 98 - V.17 short train, 9600 bps
- 121 - V.17, 12,000 bps
- 122 - V.17 short train, 12,000 bps
- 145 - V.17, 14,400 bps
- 146 - .17 short train, 14,400 bps

AT+FRM<mod> - Receive Fax (see AT+FRH for mod values)

AT+FRS<time> - Receive Silence

AT+FRTn - Receive Test Data

AT+FTH<mod> - Transmit HDLC Data (see AT+FRH for mod values)

AT+FTM<mod> - Transmit Fax (see AT+FRH for mod values)

AT+FTS<time> - Transmit Silence

AT+FTTn - Transmit Test Data

Digits	Verbose	Description	Digits	Verbose	Description
0	OK	Successfully executed command line	48	CARRIER 4800	4800 bps carrier received
1	CONNECT	300 bps connection	49	CARRIER 7200	7200 bps carrier received
2	RING	Ring signal detected	50	CARRIER 9600	9600 bps carrier received
3	NO CARRIER	Carrier not detected/lost	51	CARRIER 12000	12,000 bps carrier received
4	ERROR	Error in command line	52	CARRIER 14400	14,400 bps carrier received
5	CONNECT		53	CARRIER 16800	16,800 bps carrier received
6	NO DIAL TONE	No dial tone detected	54	CARRIER 19200	19,200 bps carrier received
7	BUSY	Busy signal detected	55	CARRIER 21600	21,600 bps carrier received
8	NO ANSWER	5 second silence not detected	56	CARRIER 24000	24,000 bps carrier received
10	CONNECT 2400	2400 bps Connection	57	CARRIER 26400	26,400 bps carrier received
11	CONNECT 4800	4800 bps Connection	58	CARRIER 28800	28,800 bps carrier received
12	CONNECT 9600	9600 bps Connection	59	CONNECT 16800	16,800 bps Connection
13	CONNECT 7200	7200 bps Connection	61	CONNECT 21600	21,600 bps Connection
14	CONNECT 12000	12,000 bps Connection	62	CONNECT 24000	24,000 bps Connection
15	CONNECT 14400	14,400 bps Connection	63	CONNECT 26400	26,400 bps Connection
16	CONNECT 19200	19,200 bps Connection	64	CONNECT 28800	28,800 bps Connection
17	CONNECT 38400	38,400 bps Connection	66	COMPRESSION: CLASS 5	MNP5 data compression
18	CONNECT 57600	57,600 bps Connection	67	COMPRESSION: V.42bis	V.42bis data compression

Digits	Verbose	Description	Digits	Verbose	Description
19	CONNECT 115200	115200 bps Connection	69	COMPRESSION: NONE	No data compression
22	CONNECT 75TX/1200RX	V.23 originate connection	76	PROTOCOL: NONE	No error correction
23	CONNECT 1200TX/75RX	V.23 answer connection	77	PROTOCOL: LAPM	LAPM error correction
33	FAX	Fax connection	80	PROTOCOL: ALT	MNP error correction
35	DATA	Connection in Fax mode	81	PROTOCOL: ALT CELLULAR	MNP10 error correction
40	CARRIER 300	300 bps carrier received	+F4	+FCERROR	Fax carrier error
44	CARRIER 1200/75	V.23 reverse channel carrier received			
45	CARRIER 75/1200	V.23 forward channel carrier received			
46	CARRIER 1200	1200 bps carrier received			
47	CARRIER 2400	2400 bps carrier received			

Appendix B. Accessories

Table B.1 lists user replaceable parts. Please contact the factory for further information.

Table B.1 Accessories

Part Number	Description
15847-001	Phone Home Power Outage battery pack
6005-254	Non-Volatile RAM backup battery
4195-263	Security jumpers (for front panel lockout)
1086-197	S-base outer globe (w/pushbuttons)
6002-656	S-base to A-base adapter assembly
12648-001	A-base adapter locking ring
Consult factory	Optical Pickup Assembly
1086-405	Modem cable (3 ft.), S-base unit
1086-217	I/O interface cable (3 ft.), S-base unit
1083-602	*JEMWare* User Manual
1083-601	*JEMRead* Data Retrieval Software Manual
1086-384	Ci20 Protocol Reference Manual
*Consult factory	Replacement Circuit Boards

* When ordering spare or replacement circuit boards, have the meter's Model Number and Serial Number available.

Appendix C. Electrostatic Discharge

Electrostatic Discharge Prevention

Static, by definition, is designating or producing stationary electrical charges such as those resulting from friction. An electrostatic potential is produced by friction between non-conductive materials and can best be visualized as a field between two charged plates. The electrostatic potential exists until the difference in the potential is overcome.

All meter shop work must be performed at static-protected work stations following properly prescribed static-control practices. Unless controlled, electrostatic discharge can destroy or weaken solid-state electronic components and assemblies.

Failure Mode

Failure of a solid-state component due to static discharge is characterized by partial or complete destruction of a semiconductor junction or a microscopic resistive or capacitive element within a circuit device. Failure is most common in CMOS, very low-energy devices.

Destruction of a circuit is immediately detectable and is remedied by normal troubleshooting and repair methods. However, the common condition of partial damage induced by low-level static discharge is not immediately detectable. Thus, the damaged component may continue to operate normally, but in a weakened state. Repeated exposure of the same component to similar low levels of static discharge can produce cumulative damage, ultimately leading to failure.

Static damage can be avoided by practical methods accessible to anyone handling solid-state components or assemblies.

Completely assembled products are only minimally vulnerable to static damage, and then only under the most severe of static-prone environments. Consequently, completely assembled products can usually be handled in normal work environments, indoors and outdoors, with little risk of static damage.

If a product is disassembled to any level, all exposed or removed electronic modules must be considered vulnerable to static damage and handled accordingly. There is no truly safe level of exposure to electrostatic discharge. However, the presence of a static charge or static field is not, in itself, damaging to electronic components.

Subassemblies from a dismantled product cannot be considered static protected by design. In fact, depending on the design and conductive mass of the connected circuitry, components in subassemblies may be more vulnerable to static damage than loose components of the same type. Therefore, the objectives of static control cannot be met by indiscriminate handling of subassemblies or loose components.

Handling a printed-circuit-board assembly by its edges without employing static protection does not preclude the risk of static damage to its components. Effective static- control methods cannot be executed without proper tools and equipment.

All static-control methods relate to one simple principle: provide alternate, intentional paths for grounding electrostatic charges away from or around the devices to be protected. Static control is the employment of tools and equipment to predetermine the flow path of this current.

Any two physical bodies, conductive or nonconducting, can be the source of an electrostatic discharge if either is charged to a different level of electrostatic potential. As these two physical bodies come in contact or proximity, equilibrium is achieved by a sudden flow of current.

Most people associate a static discharge with a small blue arc and a sharp snapping noise. Static charges of a level too low to produce a detectable arc can still damage unprotected electronic components.

Another important consideration is that even though a safe encounter has been achieved between two physical bodies, any subsequent encounter with a third, fourth, or more bodies must be protected in the same manner since a static potential difference may exist between the, now combined, first two bodies and any unknown new body.

WARNING

The first step in the above example is to de-energize the meter so that the meter is completely isolated from all service lines. Never dismantle an energized meter.

The following static-control equipment is required:

- Conductive work mat
- Ground cord attached to true earth ground
- Conductive wrist strap
- Electrically conductive bag

CAUTION

Unless you are certain that the meter enclosure is properly earth bonded, do not attach the ground cord to the meter enclosure. Never attach a ground cord to the distribution system neutral or any other point inside the meter enclosure, as this can present a serious safety hazard.

Attach the conductive work mat and the conductive wrist strap to the ground cord. Put on the wrist strap and remove the assembly from the meter. If work is to be performed on the assembly at the metering site, perform it on the grounded work mat.

If the assembly is to be transported to the meter shop or other off-site location, insert the assembly into a conductive, antistatic bag for safe transportation. If the assembly has a battery installed, remove the battery before inserting into the bag for transportation. Conductive, antistatic bags can cause a battery to discharge during the transportation process.

If sensitive components are removed from the assembly at the meter site and are to be reused, insert the components—with all component leads piercing into a piece of conductive foam carrier—into an antistatic bag for safe transportation.

Static kits including mat, wrist strap, cord, and clip are available through your local electronics supplier.

Appendix D. DNP Serial Communications

Introduction

Distributed Network Protocol (DNP 3.0) is an industry standard protocol for SCADA communications between Master Stations, Host computers, Remote Terminal Units, and Intelligent Electronics Devices, such as the Ci20 meter. It is a public domain, non-proprietary protocol based on the IEC-870 standards, and is intended primarily for use in SCADA-like systems.

DNP as a protocol provides efficient, robust data communications through a system of 32-bit data link CRCs (Cyclical Redundancy Checks) and confirmation messages. However, DNP is much more than an error-detection-and-correction scheme. A DNP-compliant device, from the protocol's point of view, is considered a group of data *objects*, each of which contains one or more *points*. The DNP protocol specification defines the allowable object types and what constitutes a *point* for that object type.

DNP is *not* intended to be a general-purpose two-way communications link. Rather, it is highly optimized for SCADA and automation applications involving relatively small amounts of near-real-time data that is often read by the DNP master every few seconds. In the case of the Ci20, it is *not* used as a means of controlling or reconfiguring the meter.

DNP v3.00 Device Profile

The purpose of this document is to describe the specific implementation of the **D**istributed **N**etwork **P**rotocol (DNP) 3.0 within the Ci20 meter. This document, in conjunction with the DNP 3.0 Basic 4 Document Set, and the DNP Subset Definitions Document, provides complete information on how to communicate with the Ci20 meter via the DNP 3.0 protocol.

Ci20 uses the Triangle MicroWorks™, Inc. DNP 3.0 Slave Source Code Library Version 2.19. This implementation of DNP 3.0 is fully compliant with DNP 3.0 Subset Definition Level 2, contains many Subset Level 3 features, and contains some functionality even beyond Subset Level 3.

The following sections, in conjunction with the Device Profile Document, provide a complete interoperability/configuration guide for the Ci20 meter:

- the Implementation Table
- the Point List Tables
- Configuration methods

DNP V3.00
DEVICE PROFILE DOCUMENT

Vendor Name: AMETEK Power Instruments

Device Name: Ci20, using the Triangle MicroWorks, Inc. DNP 3.0 Slave Source Code Library, Ver 2.19

Highest DNP Level Supported:	Device Function:
For Requests: Level 2 **For Responses: Level 2**	☐ Master ☒ Slave

Notable objects, functions, and/or qualifiers supported in addition to the Highest DNP Levels Supported (the complete list is described in the attached table):

For static (non-change-event) object requests, request qualifier codes 00 and 01 (start-stop), 07 and 08 (limited quantity), and 17 and 28 (index) are supported in addition to request qualifier code 06 (no range – or all points). Static object requests received with qualifiers 00, 01, 06, 07, or 08, is responded with qualifiers 00 or 01. Static object requests received with qualifiers 17 or 28 is responded with qualifiers 17 or 28. For change-event object requests, qualifiers 17 or 28 are always responded.

The read and write function code for Object 50 (Time and Date), variation 1, is supported.

Maximum Data Link Frame Size (octets):	Maximum Application Fragment Size (octets):
Transmitted:**292** Received **292**	Transmitted: **2048** Received: **2048**
Maximum Data Link Re-tries: **Configurable from 0 to 255 – Via *CiSET***	Maximum Application Layer Re-tries: **None**

Requires Data Link Layer Confirmation:

Configurable as: Never, Only for multi-frame messages, or Always via *CiSET*

Requires Application Layer Confirmation:

When sending multi-fragment responses
Sometimes

Timeouts while waiting for:

Data Link Confirm:	**Configurable via *CiSET***
Complete Appl. Fragment:	**None**
Application Confirm:	**Configurable via *CiSET***
vi vids Complete Appl. Response:	**None**

Others:

Transmission Delay:	**Configurable, via *CiSET***
Inter-character Timeout:	**1 sec.**
Need Time Delay:	**Configurable, via *CiSET***
Frozen Counter Event scanning period:	**FIXED AT 5 seconds**

Sends/Executes Control Operations:

WRITE Binary Outputs	**Never**
SELECT/OPERATE	**Never**
DIRECT OPERATE	**Never**
DIRECT OPERATE – NO ACK	**Never**
Count > 1	**Never**
Pulse On	**Never**
Pulse Off	**Never**
Latch On	**Never**
Latch Off	**Never**
Queue	**Never**
Clear Queue	**Never**

Reports Binary Input Change Events when no specific variation requested:	Reports time-tagged Binary Input Change Events when no specific variation requested:
Never	**Never**
Sends Unsolicited Responses: Never	Sends Static Data in Unsolicited Responses: **Never** No other options are permitted.
Default Counter Object/Variation: **Default Object: 20** **Default Variation: 5** **Point-by-point list attached**	Counters Roll Over at: **32 Bits** **Other Value: 999,999,999** **Point-by-point list attached**

Sends Multi-Fragment Responses:

Yes

Figure D.1 DNP V3.00 Device Profile Document

The Ci20 Implementation

The Ci20 DNP implementation conforms to the standard for a Level II slave device, with some additions. Implementation consists of the following *static* objects:

- (38) Single-bit Binary Input without flag (Object 1 Variation 1)
- (50) Analog Inputs, configurable with *JEMWare* for either 32-bit analog input without flag points (Object 30 Variation 3), or 16-bit analog input without flag points (Object 30 Variation 4)
- A configurable number (up to 64) of 32-bit counters (Object 20 Variation 5) that can be assigned to any register in the Normal or alternate display set
- A corresponding number of 32-bit frozen counter without flag (Object 21 variation 5) that represent the values of the counter points at the time of the last meter freeze

Implementation Table

The following table identifies the variations, function codes, and qualifiers supported by the Ci20 meter in both request messages and in response messages.

For static (non-change-event) objects, requests sent with qualifiers 00, 01, 06, 07, or 08, are responded with qualifiers 00 or 01. Static object requests sent with qualifiers 17 or 28 are responded with qualifiers 17 or 28. For change-event objects, qualifiers 17 or 28 are always responded.

In Table D.1, text shaded as Subset Level 3 indicates Subset Level 3 functionality (beyond Subset Level 2).

Text shaded as beyond Subset Level 3 indicates functionality beyond Subset Level 3.

Table D.1 Implementation Table

Object			Request (Library parses)		Response (Library responds with)	
Object Number	**Variation Number**	**Description**	**Function Codes (dec)**	**Qualifier Codes (hex)**	**Function Codes (dec)**	**Qualifier Codes (hex)**
1	0	Binary Input (Variation 0 is used to request default variation)	**1** (read)	00, 01 (start-stop) 06 (no range, or all)		
				07, 08 (limited qty) 17, 28 (index)		
1	1	Binary Input	**1** (read)	00, 01 (start-stop) 06 (no range, or all)	129 (response)	00, 01 (start-stop)
						17, 28 **(index –**
				07, 08 (limited qty) 17, 28 (index)		
20	0	Binary Counter (Variation 0 is used to request default variation)	1 (read)	00, 01 (start-stop) 06 (no range, or all)		
				07, 08 (limited qty) 17, 28 (index)		
20	5	32-Bit Binary Counter without Flag	1 (read)	00, 01 (start-stop) 06 (no range, or all)	129 (response)	00, 01 (start-stop)
						17, 28 **(index –**
				07, 08 (limited qty) 17, 28 (index)		
21	0	Frozen Counter (Variation 0 is used to request default variation)	1 (read)	00, 01 (start-stop) 06 (no range, or all)		
				07, 08 (limited qty) 17, 28 (index)		
21	9	32-Bit Frozen Counter without Flag	1 (read)	00, 01 (start-stop) 06 (no range, or all)	129 (response)	00, 01 (start-stop)
						17, 28 **(index –**
				07, 08 (limited qty) 17, 28 (index)		
23	0	Frozen Counter Event (Variation 0 is used to request default variation)	1 (read)	06 (no range, or all) 07, 08 (limited qty)		
23	5	32-Bit Frozen Counter Event with Time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response)	17, 28 (index)
30	0	Analog Input (Variation 0 is used to request default variation)	(read)	00, 01 (start-stop) 06 (no range, or all)		
				07, 08 (limited qty) 17, 28 (index)		
30	3	32-Bit Analog Input without Flag	(read)	00, 01 (start-stop) 06 (no range, or all)	129 (response)	00, 01 (start-stop)
						17, 28 (index –see note 2)
				07, 08 (limited qty) 17, 28 (index)		

Table D.1 Implementation Table (Continued)

Object			Request (Library parses)		Response (Library responds with)	
Object Number	**Variation Number**	**Description**	**Function Codes (dec)**	**Qualifier Codes (hex)**	**Function Codes (dec)**	**Qualifier Codes (hex)**
30	5	short floating point	(read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index –see note 2)
50	0	Time and Date	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index –see note 2)
50	1	Time and Date	1 (read) 2 (write)	00, 01 (start-stop) 06 (no range, or all) 07 (limited qty=1) 08 (limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index –see no
52	2	Time Delay Fine			129 (response)	07 (limited qty) (qty = 1)
60	0	Class 0, 1, 2, and 3 Data	1 (read)	06 (no range, or all)		
60	1	Class 0 Data	1 (read)	06 (no range, or all)		
60	2	Class 1 Data	1 (read)	06 (no range, or all) 07, 08 (limited qty)		
60	3	Class 2 Data	1 (read)	06 (no range, or all) 07, 08 (limited qty)		
60	4	Class 3 Data	1 (read)	06 (no range, or all) 07, 08 (limited qty)		
80	1	Internal Indications	2 (write)	00 (start-stop) (index must =7)		
No Object (function code only) –See Note 3			13 (cold restart)			
No Object (function code only)			14 (warm restart)			
No Object (function code only)			23 (delay meas.)			

Note 1 - For static (non-change-event) objects, qualifiers 17 or 28 are only responded when a request is sent with qualifiers 17 or 28, respectively. Otherwise, static object requests sent with qualifiers 00, 01, 06, 07, or 08, are responded with qualifiers 00 or 01. (For change-event objects, qualifiers 17 or 28 are always responded.)

Note 2 - A cold restart is implemented as a warm restart – the Ci20 meter is not restarted, but the DNP process is restarted.

Point List

The tables in the following sections identify all the individual data points provided by the implementation of DNP 3.0 in the Ci20 meter.

Binary Input Points

The Binary input points represent such things as:

- Contact input status
- Threshold alarm conditions
- Site monitor alarm conditions
- Phase potential status

Ci20 can be configured with up to 40 Binary Input Points in DNP. You can assign any of the following Binary Inputs to any Binary Input Point:

- Contact Input 1 status
- Contact Input 2 status
- Voltages out of sequence alarm
- Neutral over current alarm
- Neutral current swell alarm
- Phase C under current alarm
- Phase C over current alarm
- Phase C power reversed alarm
- Phase C PF high alarm
- Phase C PF low alarm
- Phase C voltage sag alarm
- Phase C under voltage alarm
- Phase C voltage swell alarm
- Phase C over voltage alarm
- Phase B under current alarm
- Phase B over current alarm
- Phase B power reversed alarm
- Phase B PF high alarm
- Phase B PF low alarm
- Phase B voltage sag alarm
- Phase B under voltage alarm
- Phase B voltage swell alarm
- Phase B over voltage alarm
- Phase A under current alarm
- Phase A over current alarm
- Phase A power reversed alarm
- Phase A PF high alarm
- Phase A PF low alarm
- Phase A voltage sag alarm
- Phase A under voltage alarm
- Phase A voltage swell alarm
- Phase A over voltage alarm
- Threshold Alarm 1
- Threshold alarm 2
- Threshold alarm 3
- Threshold alarm 4
- Phase A potential status
- Phase B potential status
- Phase C potential status
- Loss of Phase Potential
- End of Demand Interval
- Fatal Error
- Non-fatal Error

Ci20's default configuration has the Binary Input Points assigned in Table D.2.

Table D.2 Binary Input Point Assignments

Point Index	Binary Input Name/Description
0	Contact Input 1 status
1	Contact Input 2 status
2	Voltages out of sequence alarm
3	Neutral over current alarm
4	Neutral current swell alarm
5	Phase C under current alarm
6	Phase C over current alarm
7	Phase C power reversed alarm
8	Phase C PF high alarm
9	Phase C PF low alarm
10	Phase C voltage sag alarm
11	Phase C under voltage alarm
12	Phase C voltage swell alarm
13	Phase C over voltage alarm
14	Phase B under current alarm
15	Phase B over current alarm
16	Phase B power reversed alarm
17	Phase B PF high alarm
18	Phase B PF low alarm
19	Phase B voltage sag alarm
20	Phase B under voltage alarm
21	Phase B voltage swell alarm
22	Phase B over voltage alarm

Table D.2 Binary Input Point Assignments (Continued)

Point Index	Binary Input Name/Description
23	Phase A under current alarm
24	Phase A over current alarm
25	Phase A power reversed alarm
26	Phase A PF high alarm
27	Phase A PF low alarm
28	Phase A voltage sag alarm
29	Phase A under voltage alarm
30	Phase A voltage swell alarm
31	Phase A over voltage alarm
32	Threshold Alarm 1
33	Threshold alarm 2
34	Threshold alarm 3
35	Threshold alarm 4
36	Phase A potential status
37	Phase B potential status
38	Phase C potential status

Counters

Counters are implemented as 32-bit counter without flag (Object 20 Var 5). For the counter point list, the user can select any Normal, Alternate, or Internal (not Test) display register to map to each point in the counter list. Display registers may contain demand or instantaneous readings as well as consumption totals. This list can be configured to contain up to 64 counter points. In addition to the Normal and Alternate register set, Ci20 has an internal register list consisting of 49 various measurements. Using *JEMWare*, the counter point list can be configured to be any mix of Normal, Alternate or Internal registers (up to a total of 64 points). Each numeric counter point value is represented as the corresponding register value times a user-selected scaling factor.

Registers in the Normal and Alternate display lists are set by the user. The Internal list contains these registers:

Watthours Delivered
Watthours Received
VARhours Delivered
VARhours Received
VAhours Delivered
VAhours Received
Qhours Delivered
Qhours Received
Amphours
Volt Squared hours
Amp Squared hours
Average PF Delivered Phase A
Average PF Delivered Phase B
Average PF Delivered Phase C
Average PF Delivered Polyphase
Average PF Received Phase A
Watt Delivered Past Interval Demand
VAR Delivered Past Interval Demand
VA Delivered Past Interval Demand
Amp Phase A Past Interval Demand
Amp Phase B Past Interval Demand
Amp Phase C Past Interval Demand
Neutral Amp Past Interval Demand
Peak Demand Watt Delivered
Peak Demand VA Delivered
Peak Demand Amp Phase A
Peak Demand Amp Phase B
Peak Demand Amp Phase C
Peak Demand Neutral Amp
Peak Demand Watt Delivered at last BPR
Peak Demand VAR Delivered at last BPR
Peak Demand VA Delivered at last BPR
Time of Peak Demand Watt Delivered
Time of Peak Demand VAR Delivered
Time of Peak Demand VA Delivered
Time of Peak Demand Amp Phase A
Time of Peak Demand Amp Phase B
Time of Peak Demand Amp Phase C
Time of Peak Demand Neutral Amp
Time of Peak Watt Delivered at last BPR
Time of Peak VAR Delivered at last BPR
Time of Peak VA Delivered at last BPR
PF at Peak Watt Delivered at last BPR
PF at Peak VAR Delivered at last BPR
PF at Peak VA Delivered at last BPR
Watt Delivered Predicted Demand
VAR Delivered Predicted Demand
VA Delivered Predicted Demand

Other data formats that can be assigned to display registers include:

- Time and Date registers are represented as seconds since midnight 1/1/70
- Diagnostic and String register types are represented as 0
- Status registers are represented as a direct 32-bit mask value.

The corresponding frozen counter object is implemented as Object 21 Variation 9. The values of the points in this object represent the values of the corresponding counter points at the time of the last register freeze.

In Ci20, all static data is permanently assigned to Class 0.

A Ci20 register configured as a DNP Counter point may contain a value as large as 999,999,999 (nine digits). Some DNP master devices cannot accept counter values this large. You can configure Ci20 to restrict the reported value of counter points to 3, 4, 5, 6, 7, or 8 digits, or allow the full 9-digit precision to be reported. Restricting the number of digits reported affects only DNP counter points, not the actual display registers.

Ci20's default configuration has Counter Points assigned as in Table D.3.

Table D.3 Counter Point Assignments

Point Index	Counter Name / Description
0	Internal – system Watthrs delivered x selected scale
1	Internal – system Watthrs received x selected scale
2	Internal – system VARhrs delivered x selected scale
3	Internal – system VARhrs received x selected scale
4	Internal – system VAhours delivered x selected scale
5	Internal – system VAhours received x selected scale
6	Internal – system Qhrs delivered x selected scale
7	Internal – system Qhrs received x selected scale
8	Internal – system Amphrs x selected scale
9	Internal – system V2h x selected scale
10	Internal – system A2H x selected scale

Analog Inputs

Analog Inputs are implemented as 32-bit analog input without flag (object 30 Var 3) points, or 16-bit analog input without flag (object 30 Var 4) points. A total of up to 140 points are supported, which represent such things as:

- Instantaneous Per phase Watts, VARs, VA, Volts, Amps, and Power Factor
- Line frequency
- Per-phase THD for volts and Amps
- Per-phase V^2 and A^2
- Bi-directional Watts and VARs

32-Bit Inputs

These inputs are represented in SECONDARY units, and up to 3 decimal places of precision can be obtained by entering a scale value of 1000. For conversion to primary units, multiply the point value by the appropriate PT and/or CT ratio.

Ci20's default configuration has Analog Input Points assigned as in Table D.4.

Table D.4 Analog Input Point Assignments

Point Index	Analog Input Name / Description	Scaling
0	Instantaneous Watts, Phase A, Del	x1000
1	Instantaneous Watts, Phase A, Rec	x1000
2	Instantaneous Watts, Phase B, Del	x1000
3	Instantaneous Watts, Phase B, Rec	x1000
4	Instantaneous Watts, Phase C, Del	x1000
5	Instantaneous Watts, Phase C, Rec	x1000
6	Instantaneous Watts, Poly, Del	x1000
7	Instantaneous Watts, Poly, Rec	x1000
8	Instantaneous VARs, Phase A, Del	x1000
9	Instantaneous VARs, Phase A, Rec	x1000
10	Instantaneous VARs, Phase B, Del	x1000
11	Instantaneous VARs, Phase B, Rec	x1000

Table D.4 Analog Input Point Assignments (Continued)

Point Index	Analog Input Name / Description	Scaling
12	Instantaneous VARs, Phase C, Del	x1000
13	Instantaneous VARs, Phase C, Rec	x1000
14	Instantaneous VARs, Poly, Del	x1000
15	Instantaneous VARs, Poly, Rec	x1000
16	Instantaneous VA, Phase A, Del	x1000
17	Instantaneous VA, Phase A, Rec	x1000
18	Instantaneous VA, Phase B, Del	x1000
19	Instantaneous VA, Phase B, Rec	x1000
20	Instantaneous VA, Phase C, Del	x1000
21	Instantaneous VA, Phase C, Rec	x1000
22	Instantaneous VA, Poly, Del	x1000
23	Instantaneous VA, Poly, Rec	x1000
24	Instantaneous Amps, Phase A	x1000
25	Instantaneous Amps, Phase B	x1000
26	Instantaneous Amps, Phase C	x1000
27	Instantaneous Amps, Neutral	x1000
28	Instantaneous Volts, Phase A	x1000
29	Instantaneous Volts, Phase B	x1000
30	Instantaneous Volts, Phase C	x1000
31	Frequency	x1000
32	Instantaneous PF, Phase A, Del	x1000
33	Instantaneous PF, Phase A, Rec	x1000
34	Instantaneous PF, Phase B, Del	x1000
35	Instantaneous PF, Phase B, Rec	x1000
36	Instantaneous PF, Phase C, Del	x1000

Table D.4 Analog Input Point Assignments (Continued)

Point Index	Analog Input Name / Description	Scaling
37	Instantaneous PF, Phase C, Rec	x1000
38	Instantaneous PF, Poly, Del	x1000
39	Instantaneous PF, Poly, Rec	x1000
40	Volts THD, Phase A	x1000
41	Volts THD, Phase B	x1000
42	Volts THD, Phase C	x1000
43	Amps THD, Phase A	x1000
44	Amps THD, Phase B	x1000
45	Amps THD, Phase C	x1000
46	$Volts^2$ Phase A	x1000
47	$Volts^2$ Phase B	x1000
48	$Volts^2$ Phase C	x1000
49	$Amps^2$ Phase A	x1000
50	$Amps^2$ Phase B	x1000
51	$Amps^2$ Phase C	x1000
52	$Amps^2$ Poly	x1000
53	Instantaneous Watts, Phase A, Bidirectional	x1000
54	Instantaneous Watts, Phase B, Bidirectional	x1000
55	Instantaneous Watts, Phase C, Bidirectional	x1000
56	Instantaneous Watts, Polyphase, Bidirectional	x1000
57	Instantaneous VARs, Phase A, Bidirectional	x1000
58	Instantaneous VARs, Phase B, Bidirectional	x1000
59	Instantaneous VARs, Phase C, Bidirectional	x1000

Table D.4 Analog Input Point Assignments (Continued)

Point Index	Analog Input Name / Description	Scaling
60	Instantaneous VARs, Polyphase, Bidirectional	x1000
61	Instantaneous Uncompensated Watts, Phase A, Del	x1000
62	Instantaneous Uncompensated Watts, Phase A, Rec	x1000
63	Instantaneous Uncompensated Watts, Phase B, Del	x1000
64	Instantaneous Uncompensated Watts, Phase B, Rec	x1000
65	Instantaneous Uncompensated Watts, Phase C, Del	x1000
66	Instantaneous Uncompensated Watts, Phase C, Rec	x1000
67	Instantaneous Uncompensated Watts, Poly, Del	x1000
68	Instantaneous Uncompensated Watts, Poly, Rec	x1000
69	Instantaneous Uncompensated VARs, Phase A, Del	x1000
70	Instantaneous Uncompensated VARs, Phase A, Rec	x1000
71	Instantaneous Uncompensated VARs, Phase B, Del	x1000
72	Instantaneous Uncompensated VARs, Phase B, Rec	x1000
73	Instantaneous Uncompensated VARs, Phase C, Del	x1000
74	Instantaneous Uncompensated VARs, Phase C, Rec	x1000

Table D.4 Analog Input Point Assignments (Continued)

Point Index	Analog Input Name / Description	Scaling
75	Instantaneous Uncompensated VARs, Poly, Del	x1000
76	Instantaneous Uncompensated VARs, Poly, Rec	x1000
77	Instantaneous Uncompensated VA, Phase A, Del	x1000
78	Instantaneous Uncompensated VA, Phase A, Rec	x1000
79	Instantaneous Uncompensated VA, Phase B, Del	x1000
80	Instantaneous Uncompensated VA, Phase B, Rec	x1000
81	Instantaneous Uncompensated VA, Phase C, Del	x1000
82	Instantaneous Uncompensated VA, Phase C, Rec	x1000
83	Instantaneous Uncompensated VA, Poly, Del	x1000
84	Instantaneous Uncompensated VA, Poly, Rec	x1000
85	Instantaneous Uncompensated PF, Phase A, Del	x1000
86	Instantaneous Uncompensated PF, Phase A, Rec	x1000
87	Instantaneous Uncompensated PF, Phase B, Del	x1000
88	Instantaneous Uncompensated PF, Phase B, Rec	x1000
89	Instantaneous Uncompensated PF, Phase C, Del	x1000

Table D.4 Analog Input Point Assignments (Continued)

Point Index	Analog Input Name / Description	Scaling
90	Instantaneous Uncompensated PF, Phase C, Rec	x1000
91	Instantaneous Uncompensated PF, Poly, Del	x1000
92	Instantaneous Uncompensated PF, Poly, Rec	x1000
93	Instantaneous Uncompensated Watts, Phase A, Bidirectional	x1000
94	Instantaneous Uncompensated Watts, Phase B, Bidirectional	x1000
95	Instantaneous Uncompensated Watts, Phase C, Bidirectional	x1000
96	Instantaneous Uncompensated Watts, Polyphase, Bidirectional	x1000
97	Instantaneous Uncompensated VARs, Phase A, Bidirectional	x1000
98	Instantaneous Uncompensated VARs, Phase B, Bidirectional	x1000
99	Instantaneous Uncompensated VARs, Phase C, Bidirectional	x1000
100	Instantaneous Uncompensated VARs, Polyphase, Bidirectional	x1000

16-Bit Inputs

These inputs are represented in SECONDARY units and scaled so that the meter's full-scale value is represented by 32767. The list is the same as that configured for the 32-bit Analog Input points, but the user-entered scale values are not used.

Example:

At 60 Hz, the raw value represented for frequency may be 19640. Dividing by 32767 and then multiplying by the full-scale engineering units value (Table D.5), gives the following reading:

$$\frac{19640}{32767} \times 100.0 \; = \; 59.94 Hz$$

To obtain primary units, multiply by the appropriate PT and/or CT ratios.

Ci20's default configuration has Binary Input Points assigned as in Table D.5.

Table D.5 Binary Input Point Assignments

Point Index	Analog Input Name/Description	Engineering Units Range	Scaled Range
Point Index	Analog Input Name/Description	Engineering Units Range	Scaled Range
0	Instantaneous Watts, Phase A, Del	0 – 10600 W	0 - 32767
1	Instantaneous Watts, Phase A, Rec	0 – 10600 W	0 - 32767
2	Instantaneous Watts, Phase B, Del	0 – 10600 W	0 - 32767
3	Instantaneous Watts, Phase B, Rec	0 – 10600 W	0 - 32767
4	Instantaneous Watts, Phase C, Del	0 – 10600 W	0 - 32767
5	Instantaneous Watts, Phase C, Rec	0 – 10600 W	0 - 32767
6	Instantaneous Watts, Poly, Del	0 – 31800 W	0 - 32767

Table D.5 Binary Input Point Assignments (Continued)

Point Index	Analog Input Name/Description	Engineering Units Range	Scaled Range
7	Instantaneous Watts, Poly, Rec	0 – 31800 W	0 - 32767
8	Instantaneous VARs, Phase A, Del	0 – 10600 VAR	0 - 32767
9	Instantaneous VARs, Phase A, Rec	0 – 10600 VAR	0 - 32767
10	Instantaneous VARs, Phase B, Del	0 – 10600 VAR	0 - 32767
11	Instantaneous VARs, Phase B, Rec	0 – 10600 VAR	0 - 32767
12	Instantaneous VARs, Phase C, Del	0 – 10600 VAR	0 - 32767
13	Instantaneous VARs, Phase C, Rec	0 – 10600 VAR	0 - 32767
14	Instantaneous VARs, Poly, Del	0 – 31800 VAR	0 - 32767
15	Instantaneous VARs, Poly, Rec	0 – 31800 VAR	0 - 32767
16	Instantaneous VA, Phase A, Del	0 – 10600 VA	0 - 32767
17	Instantaneous VA, Phase A, Rec	0 – 10600 VA	0 - 32767
18	Instantaneous VA, Phase B, Del	0 – 10600 VA	0 - 32767
19	Instantaneous VA, Phase B, Rec	0 – 10600 VA	0 - 32767
20	Instantaneous VA, Phase C, Del	0 – 10600 VA	0 - 32767
21	Instantaneous VA, Phase C, Rec	0 – 10600 VA	0 - 32767

Table D.5 Binary Input Point Assignments (Continued)

Point Index	Analog Input Name/Description	Engineering Units Range	Scaled Range
22	Instantaneous VA, Poly, Del	0 – 31800 VA	0 - 32767
23	Instantaneous VA, Poly, Rec	0 – 31800 VA	0 - 32767
24	Instantaneous Amps, Phase A	0 –20 A	0 - 32767
25	Instantaneous Amps, Phase B	0 –20 A	0 - 32767
26	Instantaneous Amps, Phase C	0 –20 A	0 - 32767
27	Instantaneous Amps, Neutral	0 –20 A	0 - 32767
28	Instantaneous Volts, Phase A	0 – 530 V	0 - 32767
29	Instantaneous Volts, Phase B	0 – 530 V	0 - 32767
30	Instantaneous Volts, Phase C	0 – 530 V	0 - 32767
31	Frequency	0 – 100 Hz	0 - 32767
32	Instantaneous PF, Phase A, Del	0 – 1.00	0 - 32767
33	Instantaneous PF, Phase A, Rec	0 – 1.00	0 - 32767
34	Instantaneous PF, Phase B, Del	0 – 1.00	0 - 32767
35	Instantaneous PF, Phase B, Rec	0 – 1.00	0 - 32767
36	Instantaneous PF, Phase C, Del	0 – 1.00	0 - 32767

Table D.5 Binary Input Point Assignments (Continued)

Point Index	Analog Input Name/Description	Engineering Units Range	Scaled Range
37	Instantaneous PF, Phase C, Rec	0 – 1.00	0 - 32767
38	Instantaneous PF, Poly, Del	0 – 1.00	0 - 32767
39	Instantaneous PF, Poly, Rec	0 – 1.00	0 - 32767
40	Volts THD, Phase A	0 – 100 %	0 - 32767
41	Volts THD, Phase B	0 – 100 %	0 - 32767
42	Volts THD, Phase C	0 – 100 %	0 - 32767
43	Amps THD, Phase A	0 – 100 %	0 - 32767
44	Amps THD, Phase B	0 – 100 %	0 - 32767
45	Amps THD, Phase C	0 – 100 %	0 - 32767
46	$Volts^2$ Phase A	0 – 280900 V^2	0 - 32767
47	$Volts^2$ Phase B	0 – 280900 V^2	0 - 32767
48	$Volts^2$ Phase C	0 – 280900 V^2	0 - 32767
49	$Amps^2$ Phase A	0 – 400 A^2	0 - 32767
50	$Amps^2$ Phase B	0 – 400 A^2	0 - 32767
51	$Amps^2$ Phase C	0 – 400 A^2	0 - 32767
52	$Amps^2$ Poly	0 – 1200 A^2	0 - 32767
53	Instantaneous Watts, Phase A, Bidirectional	-10600 to +10600 W	-32768 to +32767
54	Instantaneous Watts, Phase B, Bidirectional	-10600 to +10600 W	-32768 to +32767
55	Instantaneous Watts, Phase C, Bidirectional	-10600 to +10600 W	-32768 to +32767
56	Instantaneous Watts, Polyphase, Bidirectional	-31800 to +31800 W	-32768 to +32767

Table D.5 Binary Input Point Assignments (Continued)

Point Index	Analog Input Name/Description	Engineering Units Range	Scaled Range
57	Instantaneous VARs, Phase A, Bidirectional	-10600 to +10600 VAR	-32768 to +32767
58	Instantaneous VARs, Phase B, Bidirectional	-10600 to +10600 VAR	-32768 to +32767
59	Instantaneous VARs, Phase C, Bidirectional	-10600 to +10600 VAR	-32768 to +32767
60	Instantaneous VARs, Polyphase, Bidirectional	-31800 to +31800 VAR	-32768 to +32767
61	Instantaneous Uncompensated Watts, Phase A, Del	0 – 10600 W	0 - 32767
62	Instantaneous Uncompensated Watts, Phase A, Rec	0 – 10600 W	0 - 32767
63	Instantaneous Uncompensated Watts, Phase B, Del	0 – 10600 W	0 - 32767
64	Instantaneous Uncompensated Watts, Phase B, Rec	0 – 10600 W	0 - 32767
65	Instantaneous Uncompensated Watts, Phase C, Del	0 – 10600 W	0 - 32767
66	Instantaneous Uncompensated Watts, Phase C, Rec	0 – 10600 W	0 - 32767
67	Instantaneous Uncompensated Watts, Poly, Del	0 – 31800 W	0 - 32767
68	Instantaneous Uncompensated Watts, Poly, Rec	0 – 31800 W	0 - 32767

Table D.5 Binary Input Point Assignments (Continued)

Point Index	Analog Input Name/Description	Engineering Units Range	Scaled Range
69	Instantaneous Uncompensated VARs, Phase A, Del	0 – 10600 VAR	0 - 32767
70	Instantaneous Uncompensated VARs, Phase A, Rec	0 – 10600 VAR	0 - 32767
71	Instantaneous Uncompensated VARs, Phase B, Del	0 – 10600 VAR	0 - 32767
72	Instantaneous Uncompensated VARs, Phase B, Rec	0 – 10600 VAR	0 - 32767
73	Instantaneous Uncompensated VARs, Phase C, Del	0 – 10600 VAR	0 - 32767
74	Instantaneous Uncompensated VARs, Phase C, Rec	0 – 10600 VAR	0 - 32767
75	Instantaneous Uncompensated VARs, Poly, Del	0 – 31800 VAR	0 - 32767
76	Instantaneous Uncompensated VARs, Poly, Rec	0 – 31800 VAR	0 - 32767
77	Instantaneous Uncompensated VA, Phase A, Del	0 – 10600 VA	0 - 32767
78	Instantaneous Uncompensated VA, Phase A, Rec	0 – 10600 VA	0 - 32767

Table D.5 Binary Input Point Assignments (Continued)

Point Index	Analog Input Name/Description	Engineering Units Range	Scaled Range
79	Instantaneous Uncompensated VA, Phase B, Del	0 – 10600 VA	0 - 32767
80	Instantaneous Uncompensated VA, Phase B, Rec	0 – 10600 VA	0 - 32767
81	Instantaneous Uncompensated VA, Phase C, Del	0 – 10600 VA	0 - 32767
82	Instantaneous Uncompensated VA, Phase C, Rec	0 – 10600 VA	0 - 32767
83	Instantaneous Uncompensated VA, Poly, Del	0 – 31800 VA	0 - 32767
84	Instantaneous Uncompensated VA, Poly, Rec	0 – 31800 VA	0 - 32767
85	Instantaneous Uncompensated PF, Phase A, Del	0 – 1.00	0 - 32767
86	Instantaneous Uncompensated PF, Phase A, Rec	0 – 1.00	0 - 32767
87	Instantaneous Uncompensated PF, Phase B, Del	0 – 1.00	0 - 32767
88	Instantaneous Uncompensated PF, Phase B, Rec	0 – 1.00	0 - 32767

Table D.5 Binary Input Point Assignments (Continued)

Point Index	Analog Input Name/Description	Engineering Units Range	Scaled Range
89	Instantaneous Uncompensated PF, Phase C, Del	0 – 1.00	0 - 32767
90	Instantaneous Uncompensated PF, Phase C, Rec	0 – 1.00	0 - 32767
91	Instantaneous Uncompensated PF, Poly, Del	0 – 1.00	0 - 32767
92	Instantaneous Uncompensated PF, Poly, Rec	0 – 1.00	0 - 32767
93	Instantaneous Uncompensated Watts, Phase A, Bidirectional	-10600 to +10600 W	-32768 to +32767
94	Instantaneous Uncompensated Watts, Phase B, Bidirectional	-10600 to +10600 W	-32768 to +32767
95	Instantaneous Uncompensated Watts, Phase C, Bidirectional	-10600 to +10600 W	-32768 to +32767
96	Instantaneous Uncompensated Watts, Polyphase, Bidirectional	-31800 to +31800 W	-32768 to +32767
97	Instantaneous Uncompensated VARs, Phase A, Bidirectional	-10600 to +10600 VAR	-32768 to +32767

Table D.5 Binary Input Point Assignments (Continued)

Point Index	Analog Input Name/Description	Engineering Units Range	Scaled Range
98	Instantaneous Uncompensated VARs, Phase B, Bidirectional	-10600 to +10600 VAR	-32768 to +32767
99	Instantaneous Uncompensated VARs, Phase C, Bidirectional	-10600 to +10600 VAR	-32768 to +32767
100	Instantaneous Uncompensated VARs, Polyphase, Bidirectional	-31800 to +31800 VAR	-32768 to +32767

Events

The Ci20 DNP implementation includes frozen counter event objects. These are implemented as Object 23 Var 5, 32-Bit frozen counter with time. These provide a time-stamped snapshot of the corresponding counters at the time of freeze. The Ci20 has storage for 5 frozen event objects when all 64 points are configured (possibly more if less points are used). An event is generated at each register freeze. Each event includes all corresponding registers at the time the freeze occurred.

If event data is not desired, the generation of events can be disabled using *JEMWare*.

In Ci20, all event data is permanently assigned to Class 1.

Time and Date

Time and Date (object 50) is supported both for read and write. Using *JEMWare*, you can configure the *Write Time Interval*, which is the interval after which the Ci20 sets the *Need Time* bit in the Internal Indications.

Configuration

JEMWare software must be used to set up the configurable parameters that relate to DNP 3.0 in the Ci20, as well as configurable point assignments for Object 20. Refer to "Communication Protocols" on page 2-26 for detailed procedures.

Appendix E. MODBUS Communications

Introduction

The MODBUS protocol defines a message structure that electronic communications equipment recognizes and uses, regardless of the type of networks over which they communicate. It describes the procedure a host piece of equipment called the MASTER uses to request access to another device called the SLAVE, how it responds to requests from other devices, and how errors is detected and reported. A common format is defined for the layout and contents of message fields.

The MODBUS protocol has two distinct forms, RTU mode and ASCII mode. RTU mode essentially means binary mode, where each byte of information is transmitted as an actual 8-bit binary byte. ASCII mode packages each byte in two ASCII coded hexadecimal characters. In addition, the two modes use different methods to calculate their checksums and message packet boundaries. These methods are detailed later in this section.

Further information concerning MODBUS implementation standards can be found at the following website:

www.modicon.com/techpubs/toc7.html

The MODBUS Device Address, timeout, and communications parameters are configured via the *JEMWare* software. **Ci20 is always a MODBUS slave device.**

Communications

The following MODBUS communications parameters are configurable via *JEMWare:*

- ASCII or RTU mode
- 7 or 8 bit mode (ASCII only)
- Parity (Even/Odd/None)
- Baud Rate (1200,9600,19200,38400)
- RS-232 (full duplex) or RS-485 (half duplex) signal levels

Serial Port Connections

MODBUS Point-to-Point Connection Using RS232

This method is used for connecting the Ci20 MODBUS directly to a MODBUS Master device. The transmit and receive data pins on the MODBUS host system may vary between pin 2 and pin 3 according to the type of equipment used. In applications where an IBM compatible PC with a 9-pin D-Type connector is used, TXD is pin 3 and RXD is pin 2.

MODBUS Master	Direction	Ci20 I/O cable
DTE RXD or DCE TXD	⇒	BLUE/GREEN
DTE TXD or DCE RXD	⇐	BLUE/RED
Comm GND	-	PURPLE/WHITE

MODBUS Multidrop Connection Using RS485 (differential)

MODBUS Master	Direction	Ci20 I/O cable
XMT/RCV-	⇔	BLUE/RED
XMT/RCV+	⇔	BLUE/GREEN

NOTE

Ci20 does not implement hardware handshaking signals with RS-232 or RS-485 serial data.

The MODBUS port is connected via a pigtail I/O cable for S-base and A-Base meters (wire colors shown above).

Data Transfers using MODBUS (RTU or ASCII)

The Ci20 MODBUS implementation fully supports all data transfers with the following commands:

- **Read Output Status**(Function code 01)
- **Read Input Status**(Function code 02)
- **Read Holding Registers**(Function code 03)
- **Read Input Registers**(Function code 04)
- **Force Single Coil**(Function code 05)
- **Force Multiple Coils**(Function code 15)
- **Preset Multiple Registers**(Function code 16)

As implied by the **Read Holding Registers** command, all Ci20 available data is stored in 16-bit Holding Registers. However, these registers either holds the High Order or Low Order 16 bits (word) of a 32-bit quantity. Whenever a 32-bit quantity is accessed, the registers containing both the High Order & Low Order words must be included in the request, or the command is rejected.

The Ci20 MODBUS interface can access data in either RTU or ASCII mode. The supported Register Sets and the MODBUS Function Codes (FC) used to retrieve the data are as follows:

Function Code (FC)	Register Set
01	Read Discrete Outputs
02	Read Discrete Inputs
03	Read Holding Registers (native data types)
04	Read Input Registers (Scaled and Cascaded)
05	Force Single Discrete Outputs
15	Force Multiple Discrete Outputs
16	Preset Multiple Holding Registers

LRC Calculation (ASCII mode)

When the Ci20 MODBUS interface operates in ASCII mode, it uses LRC for error checking. The LRC value is one byte, contained in two ASCII characters. The LRC consists of the 2's complement of the byte sum of all the binary byte values (after each pair of ASCII coded hex characters are converted to a byte) of the Device Address through the last Data byte. Neither the Start of Message colon (':') nor the carriage return – line feed pair is included in the LRC calculation.

The LRC value is calculated by the transmitting device that appends the LRC to the message. The receiving device recalculates the LRC and compares it to the value in the message. If the values are not the same, the receiver ignores the message.

CRC Calculation (RTU mode)

The MODBUS interface also operates in RTU mode and uses CRC for error checking. The CRC value is two bytes, containing a 16 bit binary value. The CRC value is calculated by the transmitting device that appends the CRC to the message. The receiving device recalculates the CRC and compares it to the value in the message. If the values are not the same, the receiver does not process the message.

The CRC value is calculated according to the following procedure:

1. Initialize a 16 bit *CRC register* to 0xFFFF.
2. Place the first 8 bit character from the message and place it into a *test register.*
3. Exclusive OR the *test character* with the *CRC register,* leaving the result in the *CRC register.*
4. The *CRC register* is shifted one bit toward the least significant bit, the least significant bit is saved into a *carry register,* and the most significant bit is zero filled.
5. If the old least significant bit was zero, go to step 6, if it was one, the *CRC register* is exclusive Ored with 0xa001.
6. Repeat steps 4 and 5, seven times.
7. Using each successive character in the message, repeat steps 3 through 6.
8. The CRC is the value in the CRC register.
9. The CRC value is placed into the message in hexadecimal format with the most significant byte going into the first CRC byte and the least significant byte going into the last CRC byte.

RTU Message Framing

In RTU mode, messages start with a silence interval of at least 3.5 character times. If the SLAVE device can monitor the network bus continuously, this silence interval can be used to identify the beginning of a new message, with the first field of a new message being the Device Address. Devices that use the silence interval to detect a new message expect the entire message frame to be transmitted continuously, and do not allow a silent interval of more than 1.5 characters to occur before completion of the entire message.

The Ci20 MODBUS implementation does not monitor the network bus continuously, and thus does not detect any silence interval. Consequently, the strict rules about silence intervals is not enforced. The start of a new message is detected using a synchronization algorithm.

Table E.1 lists typical Ci20 RTU queries.

Table E.1 Typical Ci20 RTU Queries

Query Field	Read Holding Regs	Force Single Coil
Device Address	05	05
Function	03	05
Register Address	00 04	00 01
# Regs/Preset Value	00 06	FF 00
Error Check (CRC)	XX XX	XX XX

ASCII Message Framing

In ASCII mode, messages start with a 'colon' (:) character (ASCII 3A hex) and end with a 'carriage return – line feed' pair (ASCII 0D & 0A hex). The carriage return – line feed pair is optional.

The allowable characters transmitted for all other fields are hexadecimal 0-9 and A-F. SLAVE Devices monitor the network bus continuously for the colon character. When one is received, each device decodes the next field (the address field) to determine if the query is directed at it.

Intervals of up to one second can elapse between characters within the message. If a greater interval occurs, the receiving device assumes that an error has occurred.

Table E.2 lists typical Ci20 ASCII queries.

Table E.2 Typical Ci20 ASCII Queries

Query Field	Read Holding Regs	Force Single Coil
Start character	':'	':'
Device Address	'0' '5'	'0' '5'
Function	'0' '3'	'0' '5'
Register Address	'0' '0' '0' '4'	'0' '0' '0' '1'

Table E.2 Typical Ci20 ASCII Queries (Continued)

Query Field	Read Holding Regs	Force Single Coil
# Regs/Preset Value	'0' '0' '0' '6'	'F' 'F' '0' '0'
Error Check (LRC)	'X' 'X'	'X' 'X'
End characters	CR LF	CR LF

Communication Errors

Communication errors, consisting of an illegal character in ASCII mode, a Parity, LRC or CRC error, results in the message causing the error to be ignored by the meter. The MASTER Device timeouts and retransmits the message.

Exception Responses

The Ci20 MODBUS implementation can produce 1 of 3 possible exceptions:

- **Illegal Function** (Exception Code 01)
- **Illegal Data Address** (Exception Code 02)
- **Illegal Data Value** (Exception Code 03)

An **Illegal Function** is self-explanatory. If the meter receives a MODBUS query that contains a function that it does not support (anything other than 01, 02 03, 04, 05, 15 or 16), an Illegal Function (Exception 01) is returned.

The **Data Address** is the *Holding Register* or *Input Register* address. For example, an Illegal Data Address for a Function 03 command would be either a register value greater that 0xE7 or a register value that begins at the second word (Lo Order Word) of a 32-bit quantity. An Illegal Data Address for a Function 06 command would be any register other that 0x16.

The meaning of the **Data Value** depends upon the command. The Data Value for a Function 03 command is the number of Holding registers requested, starting with the first (Data Address) register. If the sum of the first register and the number of registers is either greater that 0x3F, or results in the request of only one word of any 32-bit quantity, an Illegal Data Value exception is generated.

An Exception Response is the Ci20's Device Address, the function value with the High Order Bit set to 1, and the Exception Code followed by either the LRC (ASCII mode) or the CRC (RTU mode). For example, in RTU mode an **Illegal Data Address** exception to a function 03 request ia as in Table E.3.

Table E.3 Illegal Data Address Exception to a fUnction 03 Request

Exception Byte	Contents	Example
1	Ci20 Device Address	5
2	Marked Function Code	83
3	Exception Code	02
4	High Order Byte CRC	XX
5	Low Order Byte CRC	XX

Timeouts

RTU Mode

The timeout period from the reception of a matching Device Address until that message is completed is software assignable using *JEMWare* software. If a timeout occurs, the portion of the message already processed is discarded and the meter again looks for a matching Device Address. The default timeout is 1 second, but can be configured for 100 to 65000 mS.

ASCII Mode

In ASCII mode, the timeout is meaningless to the Ci20 since it is always the SLAVE Device. Whenever a colon (**':'**) character is encountered, the MODBUS logic automatically interprets it as the start of a new message and discards any portion of the previous message. Similarly, if a timeout were to occur, any portion of the previous message would be discarded and the logic would wait for the next colon (**':'**) character, which essentially accomplishes the same purpose.

However, since the Carriage Return – Line Feed pair is optional at the end of a query message, a 1 second timer is automatically started at the end of the CRC to allow for these optional characters. If the Carriage Return – Line Feed pair is not received at the end of this 1 second timeout, the logic proceeds with processing the message.

Register Presets

In the Ci20 Modbus implementation, meter registers (Normal and Alternate) can be cleared or set to a given value with the Preset Multiple Registers command (Function Code 16). The start register specified in the command must be the Hi-order register number of the appropriate register pair, and there cannot be more than 120 registers per request. In addition, **Allow Register Presets** must be specifically enabled in the meter with *JEMWare* (Go to menu Meter Settings/Protocols/Modbus). If not enabled, Modbus exception 01 (illegal function) is returned if register presets are attempted.

Digital Output Control

The Ci20 digital outputs can be forced to a high or low state via MODBUS using either the Force Single coil (Func 05) or Force Multiple Coils (Func 15) command. To use this feature, **Allow Digital Outputs Control** must be enabled in the meter with *JEMWare*. If not enabled, Modbus Exception 01 (Illegal Function) is returned when this is attempted.

MODBUS Register Maps

Ci20 contains 6 Discrete Output registers, 39 Discrete Input Registers, 232 Holding registers, and 53 Input registers. All Holding Registers contain 32-bit data values in consecutive pairs. Thus, the individual Holding Registers 40001 through 40232 contains either the High Order Word or the Low Order Word of a 32-bit data type.

The Input Registers of the meter are stored as signed and unsigned 16-bit integers. These integers represent a value in some Engineering Unit, with a 'Scale Factor' of some number of decimal places.

The Ci20 register values are visible via MODBUS as MODBUS Holding Registers. The 32-bit register values are mapped as two consecutive MODBUS registers, with the High Order 16-bit segment first. Any or all of these MODBUS Registers can be accessed via the MODBUS Read Holding Registers (03) command, however each request must be limited to 120 Modbus registers maximum.

Table E.5 through Table E.7 show the MODBUS memory map in table form.

Table E.4 Read Output (Coil) Status (function 01) Point list

MODBUS Address	PLC Address	Register Contents
REG 00	10001	Digital Output 1
REG 01	10002	Digital Output 2
REG 02	10003	Digital Output 3
REG 03	10004	Digital Output 4
REG 04	10005	Digital Output 5
REG 05	10006	Digital Output 6

Table E.5 Read Input Status (function 02) Point List

MODBUS Address	**PLC Address**	**Register Contents**
REG 00	20001	Contact Input 1 status
REG 01	20002	Contact Input 2 status
REG 02	20003	Voltages out of sequence alarm
REG 03	20004	Neutral over current alarm
REG 04	20005	Neutral current swell alarm
REG 05	20006	Phase C under current alarm
REG 06	20007	Phase C over current alarm
REG 07	20008	Phase C power reversed alarm
REG 08	20009	Phase C PF high alarm
REG 09	20010	Phase C PF low alarm
REG 0A	20011	Phase C voltage sag alarm
REG 0B	20012	Phase C under voltage alarm
REG 0C	20013	Phase C voltage swell alarm
REG 0D	20014	Phase C over voltage alarm
REG 0E	20015	Phase B under current alarm
REG 0F	20016	Phase B over current alarm

Table E.5 Read Input Status (function 02) Point List (Continued)

REG 10	20017	Phase B power reversed alarm
REG 11	20018	Phase B PF high alarm
REG 12	20019	Phase B PF low alarm
REG 13	20020	Phase B voltage sag alarm
REG 14	20021	Phase B under voltage alarm
REG 15	20022	Phase B voltage swell alarm
REG 16	20023	Phase B over voltage alarm
REG 17	20024	Phase A under current alarm
REG 18	20025	Phase A over current alarm
REG 19	20026	Phase A power reversed alarm
REG 1A	20027	Phase A PF high alarm
REG 1B	20028	Phase A PF low alarm
REG 1C	20029	Phase A voltage sag alarm
REG 1D	20030	Phase A under voltage alarm
REG 1E	20031	Phase A voltage swell alarm
REG 1F	20032	Phase A over voltage alarm
REG 20	20033	Threshold alarm 1
REG 21	20034	Threshold alarm 2
REG 22	20035	Threshold alarm 3
REG 23	20036	Threshold alarm 4
REG 24	20037	Phase A potential status
REG 25	20038	Phase B potential status
REG 26	20039	Phase C potential status

Table E.6 Read Holding Registers (function 03) Point List

MODBUS Address	PLC Address	Signed/Unsigned	Scale Factor	Register Contents
REG 00	40001	S	1000	PT Ratio Hi
REG 01	40002	S	1000	PT Ratio Lo
REG 02	40003	S	1000	CT Ratio Hi
REG 03	40004	S	1000	CT Ratio Lo
REG 04	40005			Reserved
REG 05	40006			Reserved
REG 06	40007			Reserved
REG 07	40008			Reserved
REG 08	40009			Reserved
REG 09	40010			Reserved
REG 0A	40011	S	1000	Normal Reg 0 Hi
REG 0B	40012	S	1000	Normal Reg 0 Lo
REG 0C	40013	S	1000	Normal Reg 1 Hi
REG 0D	40014	S	1000	Normal Reg 1 Lo
REG 0E	40015	S	1000	Normal Reg 2 Hi
REG 0F	40016	S	1000	Normal Reg 2 Lo
REG 10	40017	S	1000	Normal Reg 3 Hi
REG 11	40018	S	1000	Normal Reg 3 Lo
REG 12	40019	S	1000	Normal Reg 4 Hi
REG 13	40020	S	1000	Normal Reg 4 Lo
REG 14	40021	S	1000	Normal Reg 5 Hi
REG 15	40022	S	1000	Normal Reg 5 Lo
REG 16	40023	S	1000	Normal Reg 6 Hi
REG 17	40024	S	1000	Normal Reg 6 Lo
REG 18	40025	S	1000	Normal Reg 7 Hi

Table E.6 Read Holding Registers (function 03) Point List (Continued)

MODBUS Address	PLC Address	Signed/Unsigned	Scale Factor	Register Contents
REG 19	40026	S	1000	Normal Reg 7 Lo
REG 1A	40027	S	1000	Normal Reg 8 Hi
REG 1B	40028	S	1000	Normal Reg 8 Lo
REG 1C	40029	S	1000	Normal Reg 9 Hi
REG 1D	40030	S	1000	Normal Reg 9 Lo
REG 1E	40031	S	1000	Normal Reg 10 Hi
REG 1F	40032	S	1000	Normal Reg 10 Lo
REG 20	40033	S	1000	Normal Reg 11 Hi
REG 21	40034	S	1000	Normal Reg 11 Lo
REG 22	40035	S	1000	Normal Reg 12 Hi
REG 23	40036	S	1000	Normal Reg 12 Lo
REG 24	40037	S	1000	Normal Reg 13 Hi
REG 25	40038	S	1000	Normal Reg 13 Lo
REG 26	40039	S	1000	Normal Reg 14 Hi
REG 27	40040	S	1000	Normal Reg 14 Lo
REG 28	40041	S	1000	Normal Reg 15 Hi
REG 29	40042	S	1000	Normal Reg 15 Lo
REG 2A	40043	S	1000	Normal Reg 16 Hi
REG 2B	40044	S	1000	Normal Reg 16 Lo
REG 2C	40045	S	1000	Normal Reg 17 Hi
REG 2D	40046	S	1000	Normal Reg 17 Lo
REG 2E	40047	S	1000	Normal Reg 18 Hi
REG 2F	40048	S	1000	Normal Reg 18 Lo
REG 30	40049	S	1000	Normal Reg 19 Hi
REG 31	40050	S	1000	Normal Reg 19 Lo

Table E.6 Read Holding Registers (function 03) Point List (Continued)

MODBUS Address	PLC Address	Signed/Unsigned	Scale Factor	Register Contents
REG 32	40051	S	1000	Normal Reg 20 Hi
REG 33	40052	S	1000	Normal Reg 20 Lo
REG 34	40053	S	1000	Normal Reg 21 Hi
REG 35	40054	S	1000	Normal Reg 21 Lo
REG 36	40055	S	1000	Normal Reg 22 Hi
REG 37	40056	S	1000	Normal Reg 22 Lo
REG 38	40057	S	1000	Normal Reg 23 Hi
REG 39	40058	S	1000	Normal Reg 23 Lo
REG 3A	40059	S	1000	Normal Reg 24 Hi
REG 3B	40060	S	1000	Normal Reg 24 Lo
REG 3C	40061	S	1000	Normal Reg 25 Hi
REG 3D	40062	S	1000	Normal Reg 25 Lo
REG 3E	40063	S	1000	Normal Reg 26 Hi
REG 3F	40064	S	1000	Normal Reg 26 Lo
REG 40	40065	S	1000	Normal Reg 27 Hi
REG 41	40066	S	1000	Normal Reg 27 Lo
REG 42	40067	S	1000	Normal Reg 28 Hi
REG 43	40068	S	1000	Normal Reg 28 Lo
REG 44	40069	S	1000	Normal Reg 29 Hi
REG 45	40070	S	1000	Normal Reg 29 Lo
REG 46	40071	S	1000	Normal Reg 30 Hi
REG 47	40072	S	1000	Normal Reg 30 Lo
REG 48	40073	S	1000	Normal Reg 31 Hi
REG 49	40074	S	1000	Normal Reg 31 Lo
REG 4A	40075	S	1000	Normal Reg 32 Hi

Table E.6 Read Holding Registers (function 03) Point List (Continued)

MODBUS Address	PLC Address	Signed/Unsigned	Scale Factor	Register Contents
REG 4B	40076	S	1000	Normal Reg 32 Lo
REG 4C	40077	S	1000	Normal Reg 33 Hi
REG 4D	40078	S	1000	Normal Reg 33 Lo
REG 4E	40079	S	1000	Normal Reg 34 Hi
REG 4F	40080	S	1000	Normal Reg 34 Lo
REG 50	40081	S	1000	Normal Reg 35 Hi
REG 51	40082	S	1000	Normal Reg 35 Lo
REG 52	40083	S	1000	Normal Reg 36 Hi
REG 53	40084	S	1000	Normal Reg 36 Lo
REG 54	40085	S	1000	Normal Reg 37 Hi
REG 55	40086	S	1000	Normal Reg 37 Lo
REG 56	40087	S	1000	Normal Reg 38 Hi
REG 57	40088	S	1000	Normal Reg 38 Lo
REG 58	40089	S	1000	Normal Reg 39 Hi
REG 59	40090	S	1000	Normal Reg 39 Lo
REG 5A	40091	S	1000	Normal Reg 40 Hi
REG 5B	40092	S	1000	Normal Reg 40 Lo
REG 5C	40093	S	1000	Normal Reg 41 Hi
REG 5D	40094	S	1000	Normal Reg 41 Lo
REG 5E	40095	S	1000	Normal Reg 42 Hi
REG 5F	40096	S	1000	Normal Reg 42 Lo
REG 60	40097	S	1000	Normal Reg 43 Hi
REG 61	40098	S	1000	Normal Reg 43 Lo
REG 62	40099	S	1000	Normal Reg 44 Hi
REG 63	40100	S	1000	Normal Reg 44 Lo

Table E.6 Read Holding Registers (function 03) Point List (Continued)

MODBUS Address	PLC Address	Signed/Unsigned	Scale Factor	Register Contents
REG 64	40101	S	1000	Normal Reg 45 Hi
REG 65	40102	S	1000	Normal Reg 45 Lo
REG 66	40103	S	1000	Normal Reg 46 Hi
REG 67	40104	S	1000	Normal Reg 46 Lo
REG 68	40105	S	1000	Normal Reg 47 Hi
REG 69	40106	S	1000	Normal Reg 47 Lo
REG 6A	40107	S	1000	Normal Reg 48 Hi
REG 6B	40108	S	1000	Normal Reg 48 Lo
REG 6C	40109	S	1000	Normal Reg 49 Hi
REG 6D	40110	S	1000	Normal Reg 49 Lo
REG 6E	40111	S	1000	Alternate Reg 0 Hi
REG 6F	40112	S	1000	Alternate Reg 0 Lo
REG 70	40113	S	1000	Alternate Reg 1 Hi
REG 71	40114	S	1000	Alternate Reg 1 Lo
REG 72	40115	S	1000	Alternate Reg 2 Hi
REG 73	40116	S	1000	Alternate Reg 2 Lo
REG 74	40117	S	1000	Alternate Reg 3 Hi
REG 75	40118	S	1000	Alternate Reg 3 Lo
REG 76	40119	S	1000	Alternate Reg 4 Hi
REG 77	40120	S	1000	Alternate Reg 4 Lo
REG 78	40121	S	1000	Alternate Reg 5 Hi
REG 79	40122	S	1000	Alternate Reg 5 Lo
REG 7A	40123	S	1000	Alternate Reg 6 Hi
REG 7B	40124	S	1000	Alternate Reg 6 Lo
REG 7C	40125	S	1000	Alternate Reg 7 Hi

Table E.6 Read Holding Registers (function 03) Point List (Continued)

MODBUS Address	PLC Address	Signed/Unsigned	Scale Factor	Register Contents
REG 7D	40126	S	1000	Alternate Reg 7 Lo
REG 7E	40127	S	1000	Alternate Reg 8 Hi
REG 7F	40128	S	1000	Alternate Reg 8 Lo
REG 80	40129	S	1000	Alternate Reg 9 Hi
REG 81	40130	S	1000	Alternate Reg 9 Lo
REG 82	40131	S	1000	Alternate Reg 10 Hi
REG 83	40132	S	1000	Alternate Reg 10 Lo
REG 84	40133	S	1000	Alternate Reg 11 Hi
REG 85	40134	S	1000	Alternate Reg 11 Lo
REG 86	40135	S	1000	Alternate Reg 12 Hi
REG 87	40136	S	1000	Alternate Reg 12 Lo
REG 88	40137	S	1000	Alternate Reg 13 Hi
REG 89	40138	S	1000	Alternate Reg 13 Lo
REG 8A	40139	S	1000	Alternate Reg 14 Hi
REG 8B	40140	S	1000	Alternate Reg 14 Lo
REG 8C	40141	S	1000	Alternate Reg 15 Hi
REG 8D	40142	S	1000	Alternate Reg 15 Lo
REG 8E	40143	S	1000	Alternate Reg 16 Hi
REG 8F	40144	S	1000	Alternate Reg 16 Lo
REG 90	40145	S	1000	Alternate Reg 17 Hi
REG 91	40146	S	1000	Alternate Reg 17 Lo
REG 92	40147	S	1000	Alternate Reg 18 Hi
REG 93	40148	S	1000	Alternate Reg 18 Lo
REG 94	40149	S	1000	Alternate Reg 19 Hi
REG 95	40150	S	1000	Alternate Reg 19 Lo

Table E.6 Read Holding Registers (function 03) Point List (Continued)

MODBUS Address	PLC Address	Signed/Unsigned	Scale Factor	Register Contents
REG 96	40151	S	1000	Alternate Reg 20 Hi
REG 97	40152	S	1000	Alternate Reg 20 Lo
REG 98	40153	S	1000	Alternate Reg 21 Hi
REG 99	40154	S	1000	Alternate Reg 21 Lo
REG 9A	40155	S	1000	Alternate Reg 22 Hi
REG 9B	40156	S	1000	Alternate Reg 22 Lo
REG 9C	40157	S	1000	Alternate Reg 23 Hi
REG 9D	40158	S	1000	Alternate Reg 23 Lo
REG 9E	40159	S	1000	Alternate Reg 24 Hi
REG 9F	40160	S	1000	Alternate Reg 24 Lo
REG A0	40161	S	1000	Alternate Reg 25 Hi
REG A1	40162	S	1000	Alternate Reg 25 Lo
REG A2	40163	S	1000	Alternate Reg 26 Hi
REG A3	40164	S	1000	Alternate Reg 26 Lo
REG A4	40165	S	1000	Alternate Reg 27 Hi
REG A5	40166	S	1000	Alternate Reg 27 Lo
REG A6	40167	S	1000	Alternate Reg 28 Hi
REG A7	40168	S	1000	Alternate Reg 28 Lo
REG A8	40169	S	1000	Alternate Reg 29 Hi
REG A9	40170	S	1000	Alternate Reg 29 Lo
REG AA	40171	S	1000	Alternate Reg 30 Hi
REG AB	40172	S	1000	Alternate Reg 30 Lo
REG AC	40173	S	1000	Alternate Reg 31 Hi
REG AD	40174	S	1000	Alternate Reg 31 Lo
REG AE	40175	S	1000	Alternate Reg 32 Hi

Table E.6 Read Holding Registers (function 03) Point List (Continued)

MODBUS Address	PLC Address	Signed/Unsigned	Scale Factor	Register Contents
REG AF	40176	S	1000	Alternate Reg 32 Lo
REG B0	40177	S	1000	Alternate Reg 33 Hi
REG B1	40178	S	1000	Alternate Reg 33 Lo
REG B2	40179	S	1000	Alternate Reg 34 Hi
REG B3	40180	S	1000	Alternate Reg 34 Lo
REG B4	40181	S	1000	Alternate Reg 35 Hi
REG B5	40182	S	1000	Alternate Reg 35 Lo
REG B6	40183	S	1000	Alternate Reg 36 Hi
REG B7	40184	S	1000	Alternate Reg 36 Lo
REG B8	40185	S	1000	Alternate Reg 37 Hi
REG B9	40186	S	1000	Alternate Reg 37 Lo
REG BA	40187	S	1000	Alternate Reg 38 Hi
REG BB	40188	S	1000	Alternate Reg 38 Lo
REG BC	40189	S	1000	Alternate Reg 39 Hi
REG BD	40190	S	1000	Alternate Reg 39 Lo
REG BE	40191	S	1000	Alternate Reg 40 Hi
REG BF	40192	S	1000	Alternate Reg 40 Lo
REG C0	40193	S	1000	Alternate Reg 41 Hi
REG C1	40194	S	1000	Alternate Reg 41 Lo
REG C2	40195	S	1000	Alternate Reg 42 Hi
REG C3	40196	S	1000	Alternate Reg 42 Lo
REG C4	40197	S	1000	Alternate Reg 43 Hi
REG C5	40198	S	1000	Alternate Reg 43 Lo
REG C6	40199	S	1000	Alternate Reg 44 Hi
REG C7	40200	S	1000	Alternate Reg 44 Lo

Table E.6 Read Holding Registers (function 03) Point List (Continued)

MODBUS Address	PLC Address	Signed/Unsigned	Scale Factor	Register Contents
REG C8	40201	S	1000	Alternate Reg 45 Hi
REG C9	40202	S	1000	Alternate Reg 45 Lo
REG CA	40203	S	1000	Alternate Reg 46 Hi
REG CB	40204	S	1000	Alternate Reg 46 Lo
REG CC	40205	S	1000	Alternate Reg 47 Hi
REG CD	40206	S	1000	Alternate Reg 47 Lo
REG CE	40207	S	1000	Alternate Reg 48 Hi
REG CF	40208	S	1000	Alternate Reg 48 Lo
REG D0	40209	S	1000	Alternate Reg 49 Hi
REG D1	40210	S	1000	Alternate Reg 49 Lo
REG D2	40211	U	1000	Sys Wh Del Hi
REG D3	40212	U	1000	Sys Wh Del Lo
REG D4	40213	U	1000	Sys Wh Rec Hi
REG D5	40214	U	1000	Sys Wh Rec Lo
REG D6	40215	U	1000	Sys VARh Del Hi
REG D7	40216	U	1000	Sys VARh Del Lo
REG D8	40217	U	1000	Sys VARh Rec Hi
REG D9	40218	U	1000	Sys VARh Rec Lo
REG DA	40219	U	1000	Sys VAh Del Hi
REG DB	40220	U	1000	Sys VAh Del Lo
REG DC	40221	U	1000	Sys VAh Rec Hi
REG DD	40222	U	1000	Sys VAh Rec Lo
REG DE	40223	U	1000	Sys Qh Del Hi
REG DF	40224	U	1000	Sys Qh Del Lo
REG E0	40225	U	1000	Sys Qh Rec Hi

Table E.6 Read Holding Registers (function 03) Point List (Continued)

MODBUS Address	PLC Address	Signed/Unsigned	Scale Factor	Register Contents
REG E1	40226	U	1000	Sys Qh Rec Lo
REG E2	40227	U	1000	Sys Amph Hi
REG E3	40228	U	1000	Sys Amph Lo
REG E4	40229	U	1000	Sys V2H Hi
REG E5	40230	U	1000	Sys V2H Lo
REG E6	40231	U	1000	Sys A2H Hi
REG E7	40232	U	1000	Sys A2H Lo

Table E.7 Read Input Registers (function 04) Point List

MODBUS Address	PLC Address	Register Contents	Engineering Units Range	Scaled Range
REG 00	30001	Instantaneous Watts, Phase A, Del	0 – 10600 W	0 - 32767
REG 01	30002	Instantaneous Watts, Phase A, Rec	0 – 10600 W	0 - 32767
REG 02	30003	Instantaneous Watts, Phase B, Del	0 – 10600 W	0 - 32767
REG 03	30004	Instantaneous Watts, Phase B, Rec	0 – 10600 W	0 - 32767
REG 04	30005	Instantaneous Watts, Phase C, Del	0 – 10600 W	0 - 32767
REG 05	30006	Instantaneous Watts, Phase C, Rec	0 – 10600 W	0 - 32767
REG 06	30007	Instantaneous Watts, Poly, Del	0 – 31800 W	0 - 32767
REG 07	30008	Instantaneous Watts, Poly, Rec	0 – 31800 W	0 - 32767
REG 08	30009	Instantaneous VARs, Phase A, Del	0 – 10600 VAR	0 - 32767
REG 09	30010	Instantaneous VARs, Phase A, Rec	0 – 10600 VAR	0 - 32767
REG 0A	30011	Instantaneous VARs, Phase B, Del	0 – 10600 VAR	0 - 32767
REG 0B	30012	Instantaneous VARs, Phase B, Rec	0 – 10600 VAR	0 - 32767
REG 0C	30013	Instantaneous VARs, Phase C, Del	0 – 10600 VAR	0 - 32767
REG 0D	30014	Instantaneous VARs, Phase C, Rec	0 – 10600 VAR	0 - 32767
REG 0E	30015	Instantaneous VARs, Poly, Del	0 – 31800 VAR	0 - 32767

Table E.7 Read Input Registers (function 04) Point List (Continued)

MODBUS Address	PLC Address	Register Contents	Engineering Units Range	Scaled Range
REG 0F	30016	Instantaneous VARs, Poly, Rec	0 – 31800 VAR	0 - 32767
REG 10	30017	Instantaneous VA, Phase A, Del	0 – 10600 VA	0 - 32767
REG 11	30018	Instantaneous VA, Phase A, Rec	0 – 10600 VA	0 - 32767
REG 12	30019	Instantaneous VA, Phase B, Del	0 – 10600 VA	0 - 32767
REG 13	30020	Instantaneous VA, Phase B, Rec	0 – 10600 VA	0 - 32767
REG 14	30021	Instantaneous VA, Phase C, Del	0 – 10600 VA	0 - 32767
REG 15	30022	Instantaneous VA, Phase C, Rec	0 – 10600 VA	0 - 32767
REG 16	30023	Instantaneous VA, Poly, Del	0 – 31800 VA	0 - 32767
REG 17	30024	Instantaneous VA, Poly, Rec	0 – 31800 VA	0 - 32767
REG 18	30025	Instantaneous Amps, Phase A	0 –20 A	0 - 32767
REG 19	30026	Instantaneous Amps, Phase B	0 –20 A	0 - 32767
REG 1A	30027	Instantaneous Amps, Phase C	0 –20 A	0 - 32767
REG 1B	30028	Instantaneous Amps, Neutral	0 –20 A	0 - 32767
REG 1C	30029	Instantaneous Volts, Phase A	0 – 530 V	0 - 32767
REG 1D	30030	Instantaneous Volts, Phase B	0 – 530 V	0 - 32767
REG 1E	30031	Instantaneous Volts, Phase C	0 – 530 V	0 - 32767
REG 1F	30032	Frequency	0 – 100 Hz	0 - 32767
REG 20	30033	Instantaneous PF, Phase A, Del	0 – 1.00	0 - 32767
REG 21	30034	Instantaneous PF, Phase A, Rec	0 – 1.00	0 - 32767
REG 22	30035	Instantaneous PF, Phase B, Del	0 – 1.00	0 - 32767
REG 23	30036	Instantaneous PF, Phase B, Rec	0 – 1.00	0 - 32767
REG 24	30037	Instantaneous PF, Phase C, Del	0 – 1.00	0 - 32767
REG 25	30038	Instantaneous PF, Phase C, Rec	0 – 1.00	0 - 32767
REG 26	30039	Instantaneous PF, Poly, Del	0 – 1.00	0 - 32767
REG 27	30040	Instantaneous PF, Poly, Rec	0 – 1.00	0 - 32767

Table E.7 Read Input Registers (function 04) Point List (Continued)

MODBUS Address	PLC Address	Register Contents	Engineering Units Range	Scaled Range
REG 28	30041	Volts THD, Phase A	0 – 100 %	0 - 32767
REG 29	30042	Volts THD, Phase B	0 – 100 %	0 - 32767
REG 2A	30043	Volts THD, Phase C	0 – 100 %	0 - 32767
REG 2B	30044	Amps THD, Phase A	0 – 100 %	0 - 32767
REG 2C	30045	Amps THD, Phase B	0 – 100 %	0 - 32767
REG 2D	30046	Amps THD, Phase C	0 – 100 %	0 - 32767
REG 2E	30047	$Volts^2$ Phase A	0 – 280900 V^2	0 - 32767
REG 2F	30048	$Volts^2$ Phase B	0 – 280900 V^2	0 - 32767
REG 30	30049	$Volts^2$ Phase C	0 – 280900 V^2	0 - 32767
REG 31	30050	$Amps^2$ Phase A	0 – 400 A^2	0 - 32767
REG 32	30051	$Amps^2$ Phase B	0 – 400 A^2	0 - 32767
REG 33	30052	$Amps^2$ Phase C	0 – 400 A^2	0 - 32767
REG 34	30053	$Amps^2$ Poly	0 – 1200 A^2	0 - 32767
REG 35	30054	Instantaneous Watts, Phase A, Bidirectional	-10600 to +10600W	-32768 to +32767
REG 36	30055	Instantaneous Watts, Phase B, Bidirectional	-10600 to +10600 W	-32768 to +32767
REG 37	30056	Instantaneous Watts, Phase C, Bidirectional	-10600 to +10600 W	-32768 to +32767
REG 38	30057	Instantaneous Watts, Polyphase, Bidirectional	-31800 to +31800 W	-32768 to +32767
REG 39	30058	Instantaneous VARs, Phase A, Bidirectional	-10600 to +10600 VAR	-32768 to +32767
REG 3A	30059	Instantaneous VARs, Phase B, Bidirectional	-10600 to +10600 VAR	-32768 to +32767

Table E.7 Read Input Registers (function 04) Point List (Continued)

MODBUS Address	PLC Address	Register Contents	Engineering Units Range	Scaled Range
REG 3B	30060	Instantaneous VARs, Phase C, Bidirectional	-10600 to +10600 VAR	-32768 to +32767
REG 3C	30061	Instantaneous VARs, Polyphase, Bidirectional	-31800 to +31800 VAR	-32768 to +32767
REG 3D	30062	Instantaneous Uncompensated Watts, Phase A, Del	0 – 10600 W	0 - 32767
REG 3E	30063	Instantaneous Uncompensated Watts, Phase A, Rec	0 – 10600 W	0 - 32767
REG 3F	30064	Instantaneous Uncompensated Watts, Phase B, Del	0 – 10600 W	0 - 32767
REG 40	30065	Instantaneous Uncompensated Watts, Phase B, Rec	0 – 10600 W	0 - 32767
REG 41	30066	Instantaneous Uncompensated Watts, Phase C, Del	0 – 10600 W	0 - 32767
REG 42	30067	Instantaneous Uncompensated Watts, Phase C, Rec	0 – 10600 W	0 - 32767
REG 43	30068	Instantaneous Uncompensated Watts, Poly, Del	0 – 31800 W	0 - 32767
REG 44	30069	Instantaneous Uncompensated Watts, Poly, Rec	0 – 31800 W	0 - 32767
REG 45	30070	Instantaneous Uncompensated VARs, Phase A, Del	0 – 10600 VAR	0 - 32767
REG 46	30071	Instantaneous Uncompensated VARs, Phase A, Rec	0 – 10600 VAR	0 - 32767
REG 47	30072	Instantaneous Uncompensated VARs, Phase B, Del	0 – 10600 VAR	0 - 32767
REG 48	30073	Instantaneous Uncompensated VARs, Phase B, Rec	0 – 10600 VAR	0 - 32767

Table E.7 Read Input Registers (function 04) Point List (Continued)

MODBUS Address	PLC Address	Register Contents	Engineering Units Range	Scaled Range
REG 49	30074	Instantaneous Uncompensated VARs, Phase C, Del	0 – 10600 VAR	0 - 32767
REG 4A	30075	Instantaneous Uncompensated VARs, Phase C, Rec	0 – 10600 VAR	0 - 32767
REG 4B	30076	Instantaneous Uncompensated VARs, Poly, Del	0 – 31800 VAR	0 - 32767
REG 4C	30077	Instantaneous Uncompensated VARs, Poly, Rec	0 – 31800 VAR	0 - 32767
REG 4D	30078	Instantaneous Uncompensated VA, Phase A, Del	0 – 10600 VA	0 - 32767
REG 4E	30079	Instantaneous Uncompensated VA, Phase A, Rec	0 – 10600 VA	0 - 32767
REG 4F	30080	Instantaneous Uncompensated VA, Phase B, Del	0 – 10600 VA	0 - 32767
REG 50	30081	Instantaneous Uncompensated VA, Phase B, Rec	0 – 10600 VA	0 - 32767
REG 51	30082	Instantaneous Uncompensated VA, Phase C, Del	0 – 10600 VA	0 - 32767
REG 52	30083	Instantaneous Uncompensated VA, Phase C, Rec	0 – 10600 VA	0 - 32767
REG 53	30084	Instantaneous Uncompensated VA, Poly, Del	0 – 31800 VA	0 - 32767
REG 54	30085	Instantaneous Uncompensated VA, Poly, Rec	0 – 31800 VA	0 - 32767
REG 55	30086	Instantaneous Uncompensated PF, Phase A, Del	0 – 1.00	0 - 32767
REG 56	30087	Instantaneous Uncompensated PF, Phase A, Rec	0 – 1.00	0 - 32767
REG 57	30088	Instantaneous Uncompensated PF, Phase B, Del	0 – 1.00	0 - 32767

Table E.7 Read Input Registers (function 04) Point List (Continued)

MODBUS Address	PLC Address	Register Contents	Engineering Units Range	Scaled Range
REG 58	30089	Instantaneous Uncompensated PF, Phase B, Rec	0 – 1.00	0 - 32767
REG 59	30090	Instantaneous Uncompensated PF, Phase C, Del	0 – 1.00	0 - 32767
REG 5A	30091	Instantaneous Uncompensated PF, Phase C, Rec	0 – 1.00	0 - 32767
REG 5B	30092	Instantaneous Uncompensated PF, Poly, Del	0 – 1.00	0 - 32767
REG 5C	30093	Instantaneous Uncompensated PF, Poly, Rec	0 – 1.00	0 - 32767
REG 5D	30094	Instantaneous Uncompensated Watts, Phase A, Bidirectional	-10600 to +10600W	-32768 to +32767
REG 5E	30095	Instantaneous Uncompensated Watts, Phase B, Bidirectional	-10600 to +10600 W	-32768 to +32767
REG 5F	30096	Instantaneous Uncompensated Watts, Phase C, Bidirectional	-10600 to +10600 W	-32768 to +32767
REG 60	30097	Instantaneous Uncompensated Watts, Polyphase, Bidirectional	-31800 to +31800 W	-32768 to +32767
REG 61	30098	Instantaneous Uncompensated VARs, Phase A, Bidirectional	-10600 to +10600 VAR	-32768 to +32767
REG 62	30099	Instantaneous Uncompensated VARs, Phase B, Bidirectional	-10600 to +10600 VAR	-32768 to +32767
REG 63	30100	Instantaneous Uncompensated VARs, Phase C, Bidirectional	-10600 to +10600 VAR	-32768 to +32767
REG 64	30101	Instantaneous Uncompensated VARs, Polyphase, Bidirectional	-31800 to +31800 VAR	-32768 to +32767

Ci20 contains a number of Holding Registers that facilitate its use in energy monitoring and management systems and to provide limited access to Load Profile data. This section describes those registers and their interpretation. They are read using Function Code 03, the same as the basic Holding Registers (Table E.8).

Table E.8 Extended Holding Registers (function 03)

MODBUS Register	Ci20 Parameter	Units	Format	Number of Registers
	Instantaneous			
1000	Amps, phase A	Primary milli-amps	Long	2
1002	Amps, phase B	Primary milli-amps	Long	2
1004	Amps, phase C	Primary milli-amps	Long	2
1006	Amps, phase N	Primary milli-amps	Long	2
1008	Amps polyphase	Primary milli-amps	Long	2
1010	Volts, L-L, phase A-B	Primary milli-amps	Long	2
1012	Volts, L-L, phase B-C	Primary milli-volts	Long	2
1014	Volts, L-L, phase C-A	Primary milli-volts	Long	2
1016	Volts, L-L, polyphase	Primary milli-volts	Long	2
1018	Volts, L-N, phase A-N	Primary milli-volts	Long	2
1020	Volts, L-N, phase B-N	Primary milli-volts	Long	2
1022	Volts, L-N, phase C-N	Primary milli-volts	Long	2
1024	Volts, L-N, polyphase	Primary milli-volts	Long	2
1026	Frequency	HZ.hundredths	Int	1
1027	PF Delivered, phase A	PF.milli	Int	1
1028	PF Delivered, phase B	PF.milli	Int	1
1029	PF Delivered, phase C	PF.milli	Int	1
1030	PF Delivered, polyphase	PF.milli	Int	1
1031	PF Received, phase A	PF.milli	Int	1
1032	PF Received, phase B	PF.milli	Int	1

Table E.8 Extended Holding Registers (function 03)

MODBUS Register	Ci20 Parameter	Units	Format	Number of Registers
1033	PF Received, phase C	PF.milli	Int	1
1034	PF Received, polyphase	PF.milli	Int	1
1035	THD, Amps, phase A	percent. milli	Long	2
1037	THD, Amps, phase B	percent. milli	Long	2
1039	THD, Amps, phase C	percent. milli	Long	2
1041	THD, Volts, phase A-N	percent. milli	Long	2
1043	THD, Volts, phase B-N	percent. milli	Long	2
1045	THD, Volts, phase C-N	percent. milli	Long	2
1047	THD, Volts, phase A-B	percent. milli	Long	2
1049	THD, Volts, phase B-C	percent. milli	Long	2
1051	THD, Volts, phase C-A	percent. milli	Long	2
1053	W Delivered, phase A	Primary xW.milli	Long	2
1055	W Delivered, phase B	Primary xW.milli	Long	2
1057	W Delivered, phase C	Primary xW.milli	Long	2
1059	W Delivered, polyphase	Primary xW.milli	Long	2
1061	Real/Apparent Power UOM to Kilo conversion factor	power of ten	Int	1
1062	VAR Delivered, phase A	Pri xVAR. milli	Long	2
1064	VAR Delivered, phase B	Pri xVAR. milli	Long	2
1066	VAR Delivered, phase C	Pri xVAR. milli	Long	2
1068	VAR Delivered, polyphase	Pri xVAR. milli	Long	2
1070	Reactive/Q Power UOM to Kilo Conversion Factor	power of ten	Int	1
1071	VA Delivered, phase A	Pri xVA. milli	Long	2
1073	VA Delivered, phase B	Pri xVA. milli	Long	2

Table E.8 Extended Holding Registers (function 03)

MODBUS Register	Ci20 Parameter	Units	Format	Number of Registers
1075	VA Delivered, phase C	Pri xVA. milli	Long	2
1077	VA Delivered, polyphase	Pri xVA. milli	Long	2
1079	Real/Apparent Power UOM to Kilo conversion factor	power of ten	Int	1
1080	W Received, phase A	Primary xW.milli	Long	2
1082	W Received, phase B	Primary xW.milli	Long	2
1084	W Received, phase C	Primary xW.milli	Long	2
1086	W Received, polyphase	Primary xW.milli	Long	2
1088	Real/Apparent Power UOM to Kilo conversion factor	power of ten	Int	1
1089	VAR Received, phase A	Pri xVAR. milli	Long	2
1091	VAR Received, phase B	Pri xVAR. milli	Long	2
1093	VAR Received, phase C	Pri xVAR. milli	Long	2
1095	VAR Received, polyphase	Pri xVAR. milli	Long	2
1097	Reactive/Q Power UOM to Kilo Conversion Factor	power of ten	Int	1
1098	VA Received, phase A	Pri xVA. milli	Long	2
1100	VA Received, phase B	Pri xVA. milli	Long	2
1102	VA Received, phase C	Pri xVA. milli	Long	2
1104	VA Received, polyphase	Pri xVA. milli	Long	2
1106	Real/Apparent Power UOM to Kilo conversion factor	power of ten	Int	1
1107	Watts, bi-directional, phase A	Primary xW.milli	Long	2
1109	Watts, bi-directional, phase B	Primary xW.milli	Long	2
1111	Watts, bi-directional, phase C	Primary xW.milli	Long	2
1113	Watts, polyphase, bi-directional	Primary xW.milli	Long	2

Table E.8 Extended Holding Registers (function 03)

MODBUS Register	Ci20 Parameter	Units	Format	Number of Registers
1115	Real/Apparent Power UOM to Kilo conversion factor	power of ten	Int	1
1116	VARs, bi-directional, phase A	Pri xVAR. milli	Long	2
1118	VARs, bi-directional, phase B	Pri xVAR. milli	Long	2
1120	VARs, bi-directional, phase C	Pri xVAR. milli	Long	2
1122	VAR polyphase, bi-directional	Pri xVAR. milli	Long	2
1124	Reactive/Q Power UOM to Kilo Conversion Factor	power of ten	Int	1
	Average Power Factors			
1200	PF Delivered, phase A	pf.milli	Int	1
1201	PF Delivered, phase B	pf.milli	Int	1
1202	PF Delivered, phase C	pf.milli	Int	1
1203	PF Delivered, polyphase	pf.milli	Int	1
1204	PF Received, polyphase	pf.milli	Int	1
	Consumption			
1205	Wh Delivered	pri xWh.milli	Mod 10 x 3	3
1208	Wh Received	pri xWh.milli	Mod 10 x 3	3
1211	Real/Apparent Energy UOM to Kilo conversion factor	power of ten	Int	1
1212	VARh Delivered	pri xVARh.milli	Mod 10 x 3	3
1215	VARh Received	pri xVARh.milli	Mod 10 x 3	3
1218	Reactive/Q Energy UOM to Kilo Conversion Factor	power of ten	Int	1

Table E.8 Extended Holding Registers (function 03)

MODBUS Register	Ci20 Parameter	Units	Format	Number of Registers
1219	VAh Delivered	pri xVAh.milli	Mod 10 x 3	3
1222	VAh Received	pri xVAh.milli	Mod 10 x 3	3
1225	Real/Apparent Energy UOM to Kilo conversion factor	power of ten	Int	1
1226	Qh Delivered	pri xQh.milli	Mod 10 x 3	3
1229	Qh Received	pri xQh.milli	Mod 10 x 3	3
1232	Reactive/Q Energy UOM to Kilo Conversion Factor	power of ten	Int	1
1233	Amphours	pri Ah.milli-UOM	Mod 10 x 3	3
1236	Amp^2hours	pri kAh.milli-UOM	Mod 10 x 3	3
1239	Amps/Amp^2 UOM to Kilo conversion factor	power of ten	Int	1
1240	$Volt^2$hours	pri kAh.milli-UOM	Mod 10 x 3	3
1243	$Volts^2$ UOM to Kilo conversion factor	power of ten	Int	1
	Demand			
1244	Demand - W Delivered	Primary xW.milli	Long	2
1246	Peak Demand - W Delivered	Primary xW.milli	Long	2
1248	Prev Billing Period Peak Demand - W Delivered	Primary xW.milli	Long	2
1250	Real/Apparent Power UOM to Kilo conversion factor	power of ten	Int	1

Table E.8 Extended Holding Registers (function 03)

MODBUS Register	Ci20 Parameter	Units	Format	Number of Registers
1251	Demand - VAR Delivered	Primary xVAR.milli	Long	2
1253	Peak Demand - VAR Delivered	Primary xVAR.milli	Long	2
1255	Prev Billing Period Peak Demand - VAR Delivered	Primary xVAR.milli	Long	2
1257	Reactive/Q Power UOM to Kilo Conversion Factor	power of ten	Int	1
1258	Demand - VA Delivered	Primary xVA.milli	Long	2
1260	Peak Demand - VA Delivered	Primary xVA.milli	Long	2
1262	Prev Billing Period Peak Demand - VA Delivered	Primary xVA.milli	Long	2
1264	Real/Apparent Power UOM to Kilo conversion factor	power of ten	Int	1
	Demand Prediction			
1265	Predicted Demand - W Delivered, polyphase	Primary xW.milli	Long	2
1267	Predicted Demand - VAR Delivered, polyphase	Primary xVAR.milli	Long	2
1269	Predicted Demand - VA Delivered, polyphase	Primary xVA.milli	Long	2
1271	Real/Apparent Power UOM to Kilo conversion factor	power of ten	Int	1
1272	Reactive/Q Power UOM to Kilo Conversion Factor	power of ten	Int	1
	Demand Current			
1273	Demand Current Phase A	Primary milli-amps	Long	2
1275	Demand Current Phase B	Primary milli-amps	Long	2
1277	Demand Current Phase C	Primary milli-amps	Long	2
1279	Demand Current Phase N	Primary milli-amps	Long	2

Table E.8 Extended Holding Registers (function 03)

MODBUS Register	Ci20 Parameter	Units	Format	Number of Registers
1281	Peak Demand Current Phase A	Primary milli-amps	Long	2
1283	Peak Demand Current Phase B	Primary milli-amps	Long	2
1285	Peak Demand Current Phase C	Primary milli-amps	Long	2
1287	Peak Demand Current Phase N	Primary milli-amps	Long	2
	Time of Peak Demand			
1289	W Delivered, polyphase		Time	3
1292	VAR Delivered, polyphase		Time	3
1295	VA Delivered, polyphase		Time	3
1298	Demand Current Phase A		Time	3
1301	Demand Current Phase B		Time	3
1304	Demand Current Phase C		Time	3
1307	Demand Current Phase N		Time	3
1310	Prev Billing Period Peak W Delivered		Time	3
1313	Prev Billing Period Peak VAR Delivered		Time	3
1316	Prev Billing Period Peak VA Delivered		Time	3
	Coincident Power Factor			
1319	when W Delivered was peak last billing period	PF.milli	Int	1
1320	when VAR Delivered was peak last billing period	PF.milli	Int	1
1321	when VA Delivered was peak last billing period	PF.milli	Int	1

Table E.8 Extended Holding Registers (function 03)

MODBUS Register	Ci20 Parameter	Units	Format	Number of Registers
	Pulse Inputs			
1400	Input 1		Int	1
1401	Input 2		Int	1
	Scratchpad (WRITABLE)			
1600 - 1619	20 registers writable by system		Int	1 ea
	Configuration			
1700	Meter ID or Type (unique for each Model)		Int	1
1702 - 1704	Date / Time		Time	3
1705 - 1707	Register Firmware Version		Int	3
1708	Class		Int	1
1709	Health Status		Int	1
1710	VT Ratio (x:1)		Long	2
1712	CT Ratio (x:1)		Long	2
1714	W/ VA/ Wh/ VAh Primary Unit of Measure	power of ten	Int	1
1715	VAR/ Q/ VARh/ Qh Primary Unit of Measure	power of ten	Int	1
1716	Volt Primary Unit of Measure	power of ten	Int	1
1717	Amp Primary Unit of Measure	power of ten	Int	1
1718	Volt Primary Squared Unit of Measure	power of ten	Int	1
1719	Amp Primary Squared Unit of Measure	power of ten	Int	1

Table E.8 Extended Holding Registers (function 03)

MODBUS Register	Ci20 Parameter	Units	Format	Number of Registers
1720	Connection Type		Int	1
1721	Demand Method		Int	1
1722	Demand Interval		Int	1
1723	Demand Subinterval		Int	1
1724	Configured number of display items in Normal Display List (See MODBUS registers 1800 - 1999, 12000 - 12749)		Int	1
1725	Configured number of display items in Alternate Display List (See MODBUS registers 2000 - 2199, 13000 - 13749)		Int	1
1726	Configured number of display items in Internal Display List (See MODBUS registers 14000 - 14749)		Int	1
1727	Configured number of Load Profile channels (See MODBUS registers 15000 - 15179)		Int	1
	Display Registers			
1800-1999	Normal Display List Registers (up to 50 entries)		Display	4 ea
2000 - 2199	Alternate Display List Registers (up to 50 entries)		Display	4 ea
	Load Profile			
2900 - 2919	Data Log Header		Int	22
2950 - 2985	Data Log Table of Contents (36 scratchpad registers writable by system)		Int	36

Table E.8 Extended Holding Registers (function 03)

MODBUS Register	Ci20 Parameter	Units	Format	Number of Registers
3000 - 10799	Load Profile data		LP Record	200 records
	Display Register and Load Profile Channel Descriptions			
12000 - 12749	Normal Display List Register Map / Index (50 entries)		Reg Desc	15 ea
13000 - 13749	Alternate Display List Register Map / Index (50 entries)		Reg Desc	15 ea
14000 - 14749	Internal Display List Register Map / Index (50 entries)		Reg Desc	15 ea
15000 - 15179	Load Profile Channel Map / Index (12 entries)		Reg Desc	15 ea

These MODBUS registers (Table E.9) are scaling factors expressed as powers of ten that, when multiplied by the appropriate power or energy registers, give readings in primary kilo-units (e.g. kilowatts, kilowatthours).

Table E.9 Scaling Factors for Readings in Primary Kilo-Units

MODBUS Register(s)	Measurement Type
1061, 1079, 1088, 1106, 1115, 1211, 1225, 1250, 1264, 1271	Watt, Watthour, VA, VAhour
1070, 1097, 1124, 1218, 1232, 1257, 1272,	VAR, VARhour, Q, Qhour
1239	Amp, Amp^2, Amphour, Amp^2hour
1243	$Volt^2$, $Volt^2$hour

Special Data Formats

These Registers have special or unusual formatting:

- Pulse Input 1(MODBUS register 1400): Reads 0 if Ci20 Contact Input 1 is off, 1 if on.
- Pulse Input 2 (MODBUS register 1401): Reads 0 if Ci20 Contact Input 2 is off, 1 if on.
- Meter ID (MODBUS register 1700): and unique identification number assigned by Square-D. Ci20 returns 15220.
- Register Firmware Version (MODBUS registers 1705 - 1701): Three MODBUS registers, each containing 2 digits of the Ci20 Register Firmware version number. Display each register's contents as a 2-digit hexadecimal number, and separate the registers with periods. (E.g. *B3.00.12*)
- Health Status (MODBUS register 1709): A series of bits giving the present health status of the Ci20:
(MSB)-> 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 <-(LSB)

Bit	Meaning
16	Battery Warning. Cumulative time on battery exceeds 2 years.
15	Configuration error - using default configuration
14	Site Monitor alarm condition is present
13	External status input is ON
12	Threshold 1 alarm condition is present
11	Threshold 2 alarm condition is present
10	Threshold 3 alarm condition is present
9	Threshold 4 alarm condition is present
8	(reserved)
7	(reserved)
6	(reserved)
5	(reserved)
4	(reserved)
3	Phase C voltage active
2	Phase B voltage active
1	Phase A voltage active

- VT Ratio (MODBUS registers 1710 - 1711): The meter's configured external Voltage Transformer ratio multiplied by 1000.

- CT Ratio (MODBUS registers 1712 - 1713): The meter's configured external Current Transformer ratio multiplied by 1000.
- W/ VA/ Wh/ VAh Primary Unit of Measure (MODBUS register 1714): A power of ten showing the configured Unit of Measure for Real and Apparent power and energy measurements:
  - 0 = units (watts, VA)
  - 3 = kilo units
  - 6 = mega units
  - 9 = giga units
- VAR/ Q/ VARh/ Qh Primary Unit of Measure (MODBUS register 1715): A power of ten showing the configured Unit of Measure for Reactive and Q power and energy measurements:
  - 0 = units (VAR, Q)
  - 3 = kilo units
  - 6 = mega units
  - 9 = giga units
- Volt Primary Unit of Measure (MODBUS register 1716): A power of ten showing the configured Unit of Measure for Volt measurements:
  - 0 = units (volts)
  - 3 = kilo units
  - 6 = mega units
- Amp Primary Unit of Measure (MODBUS register 1717): A power of ten showing the configured Unit of Measure for Amp measurements:
  - 0 = units (amps)
  - 3 = kilo units
  - 6 = mega units
- Volt Primary Squared Unit of Measure (MODBUS register 1718): A power of ten showing the configured Unit of Measure for Volts Squared measurements:
  - 0 = units (volts squared)
  - 3 = kilo units
  - 6 = mega units

- Amp Primary Squared Unit of Measure (MODBUS register 1719): A power of ten showing the configured Unit of Measure for Amp Squared measurements:
  - 0 = units (amps squared)
  - 3 = kilo units
  - 6 = mega units
- Connection Type (MODBUS register 1720): The meter service connection type. A 3-wire Delta connection returns 30, while a 4-wire Wye returns 40.
- Demand Method (MODBUS register 1721): A bit field indicating the demand methods configured in the meter.
  (MSB)-> 0 0 0 0 0 0 0 0 0 0 0 0 0 0 E S <-(LSB)

  Where: E is the External Demand Interval Sync Enabled bit (1 = external demand sync, 0 = internal sync).

  S is the Sliding Window Demand indicator (1 = sliding window, 0 = fixed window)
- Demand Interval (MODBUS register 1722): The Ci20's demand interval length in minutes.
- Demand Subinterval (MODBUS register 1723): The Ci20's demand subinterval length in minutes.
- Number of Normal Display Registers (MODBUS register 1724): The number of display registers (max. 50) currently configured in the Normal display list.
- Number of Alternate Display Registers (MODBUS register 1725): The number of display registers (max. 50) currently configured in the Alternate display list.
- Number of Internal Display Registers (MODBUS register 1726): The number of display registers (max. 50) currently configured in the Internal display list.
- Number of Load Profile Channels (MODBUS register 1727): The number of Load Profile pulse channels (max. 12) currently configured in the meter.

MODBUS Register Formats

These extended MODBUS holding registers come in a variety of formats. These formats are described here.

Int

The Int type is a signed 16-bit integer number. It is the basic MODBUS register.

Long

The Long is two MODBUS registers sent consecutively to form a 32-bit value. The first register contains the sign bit and the 15 most significant bits of the value. The second register contains the remaining 16 least significant bits.

Time

The Time format is three MODBUS registers sent consecutively to form a date-time group encoded thus:

	Upper 8 bits	Lower 8 bits
First register	Month (1 - 12)	Day (1 - 31)
Second register	Year (0 - 199)	Hour (0 - 23)
Third register	Minute (0 - 59)	Second (0 - 59)

Mod10 x 3

The Mod10 x 3 format is three MODBUS registers sent consecutively to form a 12-digit decimal value encoded thus:

First register	4 least significant (of 12) digits of complete value, in binary (0 - 9999)
Second register	4 middle (of 12) digits of complete value, in binary (0 - 9999)
Third register	4 most significant (of 12) digits of complete value, in binary (0 - 9999)

Therefore, the complete value is (R3 * 10^8) + (R2 & 10^4) + R1. This format can accommodate values from 0 to 999,999,999,999 decimal.

Display

The Display format varies depending on the exact definition of a given display item by the user. Ci20 Displays can contain a numeric value expressed as a Long or a Mod x 3 format with a primary scaling factor, a Long format without scaling, or a Time format.

Each Display has a corresponding Register Description that contains, among other things, a *Format Type* field that explains how to interpret that Display's data.

LP Record

The Load Profile Record contains the Load Profile data for a single interval. This format consists of a time stamp (in the Time format described here) followed by 1 to 12 pulse channels depending on the meter's configuration. Each pulse channel is three MODBUS registers in the format R1 * R2 * 10^R3. The first register is a pulse count, the second register is a pulse weight (in, for example, Watthours per pulse), and the third register is a power of ten. The complete interval's accumulation for that channel is found by multiplying the first register by the second register, then multiplying the result by 10 raised to the power in the third register.

LP Header

The Load Profile Header is a data structure (Table E.10) that describes the Ci20's implementation of Load Profile for MODBUS retrieval.

Table E.10 Ci20's Implementation of Load Profile for MODBUS Retrieval

Register Offset	Register Name	Register Description	Notes
0	Table of Contents	Beginning register of record which lists the register numbers that are being logged for this data log. (0 specifies that the data log is not being used)	This is a pointer to the block where the 1-12 channels are defined by listing the first register corresponding to the value logged in that register. Ci20 reads Register 2950
1	File Type	Specifies the file type, i.e., data log, waveform capture, etc. (Set to 1 for Data Log)	Ci20 reads 1
2	File Size	The file size in records, max = 32000	Ci20 reads 200
3	Record Size	Record size in registers, max 39 including date/time stamp. Table of contents holds (Record Size - 3) registers	Calculated by Ci20 based on Recorder Contents
4	File Mode	0 = FIFO, 1 = Fill and Hold	Always 0 for the Ci20
5	Record Entry Enable / Disable	Record entry enable (FFFF)/disable(0000) for data log files	Ci20 is FFFF by default

Table E.10 Ci20's Implementation of Load Profile for MODBUS Retrieval (Continued)

Register Offset	Register Name	Register Description	Notes
6	Entry Update Interval	Entry update interval (in minutes) for data log files synchronized to entry interval offset time	Ci20's configured Load Profile interval length, in minutes.
7	Entry Interval Offset Time	Time (in minutes) past midnight to synchronize record entry update intervals to	Always 0 for Ci20
8	Current # Records in File	Current number of records in the file	Managed by Ci20. Maximum 200
9	Current first record sequence	Current first (oldest) record sequence number in the file	Managed by Ci20. Ranges from 1 to 32000
10	Current last record sequence	Current last (newest) record sequence number in the file	Managed by Ci20. Ranges from 1 to 32000
11	Date/Time of last file reset/clear	Date/Time of last file reset/clear in 3 register format	Date & Time at which Ci20 Load Profile was reinitialized (reconfigured).
14	Allocated File Size	File size allocated during last file resize, in records	(same as Offset 2)
15	Allocated Record Size	Record size (in registers) allocated during the last file resize, including the date/time stamp	(same as Offset 3)
16	File Status	Status of the file based on actual and allocated file size and record size	Ci20 always reads 0 (OK)
17	File Location	Starting register number for file	Ci20 always reads 3000
18	Cont. WFC Segment Delay	Continuous WFC segment limit can be set in range 1-5	N/A = -32768

Table E.10 Ci20's Implementation of Load Profile for MODBUS Retrieval (Continued)

Register Offset	Register Name	Register Description	Notes
19	Cont. WFC Trigger Delay	Number of Pre-Trigger Cycles to obtain when a continuous WFC occurs. Applicable only to the Count. WFC File Only. Reserved for all others.	N/A = -32768
20	Oldest Record	Register number at start of oldest record in file.	Location of record corresponding to sequence number stored at Offset 9.
21	Newest Record	Register number at start of newest record in file.	Location of record corresponding to sequence number stored at Offset 10.

Reg Desc

Each Ci20 Display Register and Load Profile Channel has a corresponding *Register Description* (Reg Desc) that tells the host system how to interpret its data.

Every register description (Table E.11) contains 15 MODBUS registers that fully describe the Display or Load Profile Channel. Four of these registers contain bit fields that detail the operation of the Display or Channel.

Table E.11 Register Description of Display or Load Profile Channel

Offset	Name	Contents
0	Reg Type	Describes the Type (Numeric, Time, Status, ID, or Totalization) of Display Register or Load Profile channel
1	Quantity Type (Used only if Reg Type is Numeric or Totalization, otherwise contains zero)	Describes the measurement quantity of a Numeric or Totalization Display Register or Load Profile channel
2	Demand Quantity Type (Used only if Reg Type is Numeric Coincident Demand to indicate quantity of associated Peak demand. Otherwise contains zero)	If this Display Register is a Coincident Demand, this describes the measurement quantity of the Peak Demand associated with it.

Table E.11 Register Description of Display or Load Profile Channel

Offset	Name	Contents
3	Reg Format	This describes how the Display Register or Load Profile channel data is to be interpreted and formatted for display.
4	Reg ID Number	The Identification number assigned by the user to this Display Register, or the Load Profile Channel Number.
5 - 14	Text Description	20 bytes of text, padded with nulls, that the user assigned to be displayed with this Display Register. This contains all nulls for Load Profile channels.

Reg Type

The Reg Type register contains a number of bit fields that describe the basic type of the Display Register or Load Profile channel.

Reg Type: (MSB)-> t t t a a a l l d d d n n n n n <-(LSB)

Where:

- t t t is the Register Type:
  0 = Numeric (Power) Display Register or Channel
  1 = Time Display Register
  2 = Status Display Register
  3 = ID Display Register
  4 = Unused Register
  5 = Totalization Display Register or Channel
- a a a is the Display Register or Channel Algorithm:
  0 = Demand
  1 = Consumption
  2 = Average PF
  3 = Peak Demand
  4 = Instantaneous
  5 = Thermal
  6 = Peak Thermal
  7 = Demand Prediction

- l l is the Demand Algorithm, and is used only for Demand, Peak Demand, or Peak Thermal Registers or Channels:
  - For Demand Registers or Channels:

  0 = Unused

  1 = Past Interval Demand

  2 = Present Interval Demand

  - For Peak Demand Registers:

  0 = Peak Demand

  1 = Time of Peak Demand

  2 = Coincident Demand

  3 = Date of Peak Demand

  - For Peak Thermal Registers:

  0 = Peak Thermal

  1 = Time of Peak Thermal

  2 = Unused

  3 = Date of Peak Thermal
- d d d is the Display Update:

  0 = Working (value updates at any time)

  1 = Freeze (value updates on communications Freeze)

  2 = Season (value updates on TOU Season Change)

  3 = Billing Period Reset (value updates on BPR)

  4 = Cumulative (Peak Demand value accumulates on BPR)

  5 = Continuous Cumulative (Peak Demand value accumulates on BPR and Demand Interval)

- n n n n n is a Selection Number that defines which Status, ID, or Time value, or Totalization channel, this Display Register contains:
  - For Time Registers:

    0 = Present Time - present value of the meter clock

    1 = Last BPR Time - time of the last Billing Period Reset

    2 = Last Freeze Time - time of the last communications Freeze

    3 = Last Season Time - time of last Time of Use season change

    4 = Next DST Time - time of next Daylight Saving Time change

    5 = Present Date - present value of the meter clock

    6 = Last BPR Date - date of the last Billing Period Reset

    7 = Last Freeze Date - date of the last Register Freeze

    8 = Last Season Date - date of the last Time of Use season change

    9 = Next DST Date - date of the next Daylight Saving Time change

    10 = Test Time Remaining - time remaining in meter Test Mode

    11 = Demand Time Remaining - time remaining in present Demand Interval

    12 = Days On Battery - number of days meter has used backup battery power (i.e. cumulative outage time)
  - For Status Registers:

    0 = Present Status - present System Status Word.

    1 = Latched Status Word - *sticky* System Status Word. Shows conditions that have set a Status bit in the System Status Word but have since gone away.

    2 = Last BPR Status - System Status Word at last Billing Period Reset

    3 = Last Freeze Status - System Status Word at last communications Freeze

    4 = Last Season Status - System Status Word at last Time of Use season change

    5 = Register Firmware Version - Ci20 register firmware version

(no numeric value)

6 = Metrology Firmware Version - Ci20 metrology firmware version (no numeric value)

7 = Blank - blank display (no numeric value)

8 = Segment Check - all display segments active (no numeric value)

9 = Phasor V - 2- or 3-phase voltage vector display (no numeric value)

10 = Phasor A - 2- or 3-phase current vector display (no numeric value)

11 = Phasor VaIa - Phase A voltage and current vector display (no numeric value)

12 = Phasor VbIb - Phase B voltage and current vector display (no numeric value)

13 = Phasor VcIc - Phase C voltage and current vector display (no numeric value)

14 = BPR Count - cumulative number of Billing Period Resets that have occurred

15 = Outage Count - cumulative number of power outages that have occurred

- For ID Registers:

  0 = Label 1 - User-defined label 1 (default *Meter Name*)

  1 = String 1

  2 = Label 2 - User-defined label 1 (default *Administrator*)

  3 = String 2

  4 = Label 3 - User-defined label 1 (default *Location*)

  5 = String 3

  6 = Label 4 - User-defined label 1 (default *Configuration ID*)

  7 = String 4

  8 = Label 5 - User-defined label 1 (default *Account Number*)

  9 = String 5 (Selector value 9)

- For Totalization registers, the Selection Number contains the number of the Totalization Channel (1 - 12) that is being displayed.

Quantity Type

The Quantity Type register describes the basic quantity being measured by the Display Register or Load Profile channel. Quantity Type is valid only if the associated Reg Type indicates this is a Numeric or Totalization Register.

(MSB)-> q q q q e e e d d d r r r r c i <-(LSB)

Where:

- q q q q is the base electrical Measurement Quantity:

  0 = Watts (Watthours)

  1 = VAR (VARhours)

  2 = VA (VAhours)

  3 = Amps (Amphours)

  4 = Q (Qhours)

  5 = PF

  6 = Volts

  7 = Frequency

  8 = Volts THD

  9 = Amps THD

  10 = External Count (Load Profile only)

  11 = External Status (Load Profile only)

  12 = Amps Squared (Amp Squared hours)

  13 = Volts Squared (Volt Squared hours)

- e e e is the Element or Phase on which the measurement is taken:

  0 = No element - Not applicable to any element or line phase. (Frequency only)

  1 = Polyphase - Sum or net of all phases. (If Channel Quantity is Volts or Volts Squared, Polyphase means an average of all phases.)

  2 = Phase A - Measured on Phase A.

  3 = Phase B - Measured on Phase B.

  4 = Phase C - Measured on Phase C.

  5 = Neutral - Measured on Neutral line. (Amps only)

  6 = Phase Average - Average of all phases. (Amps or Amps Squared only)

- d d d is the Direction of the measured quantity

  0 = No direction - Directionless quantities such as volts or amps.

  1 = Delivered - Power flowing from the line side of the meter to the load.

  2 = Received - Power flowing from the load side of the meter to the line.

  3 = Quadrant 1 - Delivered watts, lagging VARs. (VARs only)

  4 = Quadrant 2 - Received watts, leading VARs. (VARs only)

  5 = Quadrant 3 - Received watts, lagging VARs. (VARs only)

  6 = Quadrant 4 - Delivered watts, leading VARs. (VARs only)

- r r r r is the Time of Use Rate during which the quantity is measured.

0 = Total - Register is always active.

1 = Rate A - Register measures only during TOU Rate A.

2 = Rate B - Register measures only during TOU Rate B.

3 = Rate C - Register measures only during TOU Rate C.

4 = Rate D - Register measures only during TOU Rate D.

5 = Rate E - Register measures only during TOU Rate E.

6 = Rate F - Register measures only during TOU Rate F.

7 = Rate G - Register measures only during TOU Rate G.

8 = Rate H - Register measures only during TOU Rate H.

- c is the Compensation flag:

  0 = Value has Transformer Loss Compensation applied (if applicable)

  1 = Value is not compensated.

  i is the Integrated Quantity flag:

  0 = Quantity is instantaneous or average (i.e. Demand, Instantaneous, Thermal, etc.)

  1 = Quantity is integrated (i.e. Consumption, Totalization)

Demand Quantity Type

The Demand Quantity Type register describes the basic quantity being measured by an associated Peak Demand Display Register. It uses the same bit assignments as Quantity Type described above. It is valid only if the associated Reg Type indicates this is a Coincident Demand Display Register.

Reg Format

The Reg Format register identifies the MODBUS data format used by the associated Display Register or Load Profile channel.

(MSB)-> 0 0 0 0 f f f f d d d d c c c c <-(LSB)

Where:

- f f f f is the Register Format identifier:

  0 = No value - Register or Channel contains no displayable information

  1 = Int - Display contains a single MODBUS register, remaining 3 registers are not used. (Display Registers only)

  2 = Long - Display contains a Long (2 MODBUS registers), remaining 2 registers are not used. (Display Registers only)

  3 = Time - Display contains a Time (3 MODBUS registers), last register is not used. (Display Registers only)

  4 = Long + scale - Display contains a Long (2 MODBUS registers), 1 unused register, and the last register is a Scale (power of 10). (Display Registers only)

  5 = Mod x 3 + scale - Display contains a Mod x 3 (3 MODBUS registers) and the last register is a Scale (power of 10). (Display Registers only)

  6 = Load Profile channel - Display contains one Value (1 MODBUS register), one Multiplier (1 MODBUS register), and a Scale (power of 10). (Load Profile channels occupy only 3 MODBUS registers.) (Load Profile channels only)

- d d d d is the total number of digits of the value to be displayed. (Only for Numeric or Totalization Display Registers.)
- c c c c is the number of decimal places of the value to be displayed, and is part of the total number of digits displayed. (Only for Numeric or Totalization Display Registers.)

Reg ID Number

The Identification number assigned by the user to this Display Register, or the Load Profile Channel Number. The decimal value of this number is displayed with the Display Register.

Text Description	20 bytes of text, padded with nulls, that the user assigned to be displayed with this Display Register. This contains all nulls for Load Profile channels.

Appendix F. ANSI Tables Communication

Introduction

The utility metering industry – utility companies, equipment vendors, government and standards agencies – has created a standardized method of retrieving meter data. The ANSI Standard C12.19 -1997 "Utility Industry End Device Data Tables" (or *ANSI Tables*) describes a set of data tables that are used to represent all types of metering data. The specification defines the data structures used to represent data involved in the configuration, control, and reading of utility meters. This does not define any process or behavior – it is strictly intended for data structure (table) definitions.

It is recommended that you review the Standard before operating the Ci20 meter with ANSI Tables Protocol. The Standard does not require the entire set of Data Tables to be implemented.

A complete ANSI Tables Protocol Technical Reference Manual is available from AMETEK that describes all Ci20-specific communication parameters. Refer to document 1083-609.

Table Organization

ANSI Data Tables are numbered and grouped into *Decades* that are associated with a particular metering function. For example, Decade 0 (Tables 00 - 09) describes the end device (meter) configuration, identification, and procedural capabilities. Decade 1 (Tables 10 - 19) describes data sources such as device inputs, units of measure, etc.

Individual tables are built from basic data types that are also defined in ANSI C12.19. These basic types include Boolean, integer, character, and floating-point representations of various sizes. Basic types are collected into arrays, and combinations of singles and arrays are collected into tables.

Communication Methods

Three related ANSI Standards define the protocols for transmitting ANSI Tables over various communication channels. The Ci20 meter is fully compliant with all communication types:

- ANSI C12.18-1996, "Protocol Specification for ANSI Type 2 Optical Port"
- ANSI C12.21-1999, "Protocol Specification for Telephone MODEM Communication"
- ANSI C12.22, "Protocol Specification for Interfacing to Data Communication Networks" (unapproved draft)

ANSI Type 2 Optical Port Protocol (C12.18)

ANSI C12.18 defines the physical structure and dynamic processes required to send and receive ANSI Data Tables via an optical communications interface. The Optical Port Protocol describes how to establish a connection with the meter, negotiate communication parameters, establish user identity and privileges, perform various functions, and send and receive data tables. Since the Optical Port cannot support multiple end devices on a single connection, it makes no provision for unique device addresses.

ANSI Telephone Modem Protocol (C12.21)

ANSI C12.21 defines the dynamic processes required to send and receive ANSI Data Tables via a dial-up modem connection. C12.21 does not define the process for establishing a modem connection – it picks up responsibility for communication after the modem connection is established.

The Telephone Modem Protocol describes how to negotiate communication parameters, establish user identity and privileges, perform various functions, and send and receive data tables. Since a single modem may serve multiple meters, the Telephone Modem Protocol provides for individual end device addressing on a multidrop connection.

ANSI Network Protocol (C12.22)

ANSI C12.22 defines the dynamic processes required to send and receive ANSI Data Tables via a network connection. C12.22 is not an approved standard, but is mentioned here for future reference. At this time, there is no Ci20 implementation specifically related to C12.22.

ANSI Tables Implementation in Ci20

ANSI Tables protocol is available on all Ci20 serial communication interfaces, standard or optional. You can configure a serial interface either via *JEMWare* configuration software or though the meter front-panel menu system. ANSI Tables protocol can be operated on one or more of the meter's serial interfaces. Using ANSI Tables on one serial port does not interfere with the use of ANSI Tables (or a different protocol) on any other port.

Optical Port

If a Ci20 is configured for ANSI Tables on the Optical port, it automatically uses the C12.18 Optical Port protocol. Used to connect an Optical Adapter to the meter.

Modem Port

If a Ci20 is configured for ANSI Tables on the Modem port, it automatically uses the C12.21 Telephone Modem protocol. Used for connection details.

Direct-connect (RS-232 or RS-485) Port

If a Ci20 is configured for ANSI Tables on an RS-232 or RS-485 port, it automatically uses the C12.21 Telephone Modem protocol. Used for connection details.

Supported Data Tables

Only the following tables are supported in the Ci20 meter. Rows shaded in gray are either undefined by the ANSI C12.19 Standard, or not supported by Ci20.

Decade 0

Table F.1 Decade 0 Device Configuration, Identification, and Procedure Tables

Table No.	Title	Description	Read / Write
00	General config	General info on end device configuration, data formats	R
01	Manufacturer ID	Manufacturer, HW and FW revision numbers	R
02	Device Nameplate	Nameplate data (form, class, voltage, freq, etc.)	R

Table F.1 Decade 0 Device Configuration, Identification, and Procedure Tables

Table No.	Title	Description	Read / Write
03	ED_MODE Status	Present operating mode, present error / warning status	R
04	Pending Status	Indicates pending status of tables in the meter	
05	Device Identification	Device serial number	R
06	Utility Information	Utility and installation identification	R
07	Procedure Initiate	Activate device procedures (BPR, etc.) *	W
08	Procedure Response	Results of previous Procedure Initiate (Table 07) write	R
09	(undefined)		

*Supported Procedures in Table 07 (Procedure Initiate)

Table F.2 Procedures

Procedure Number	Procedure Name	Description
3	Clear Data	Erase Registers & Load Profile, retain Configuration, try to retain Event Logs
6	Change End Device Mode	Enter or Exit Test Mode
7	Clear Standard Status Flags	Clear Health Check and other status flags
9	Remote Reset	Billing Period Reset (Season Change and new Season not supported in this procedure)
10	Set Date and/or Time	Set Time and Date
18	Log In	Establish a user session
19	Log Out	End a user session

Decade 1

Table F.3 Decade 1 - Data Source Table

Table No.	Title	Description	Read / Write
10	Dimension Sources Limiting	Maximum dimensions and end device capabilities	
11	Actual Sources Limiting	Actual parameters configured in device	R
12	Unit of Measure	Units of Measure, calculation methods (VA, etc)	R
13	Demand Control	Demand interval, subinterval, and related info	R
14	Data Control	Data source selections (?)	R?
15	Constants	?	R?
16	Source Definition	Available data sources selectable by other tables (such as Table 14)	
17	(undefined)		
18	(undefined)		
19	(undefined)		

Decade 2

Table F.4 Decade 2 – Register Tables

Table No.	Title	Description	Read / Write
20	Dimension Register Limiting	Maximum dimensions of measured data registers	
21	Actual Register	Actual function values for registers	R
22	Data Selection	Grouped lists of source indices into Table 16.	
23	Current Register Data	Current Register Data	R

Table F.4 Decade 2 – Register Tables

Table No.	Title	Description	Read / Write
24	Previous Season Data	Register Data as of most recent Season Change	R
25	Previous Demand Reset Data	Register Data as of most recent Demand Reset	R
27	Present Register Selection	Lists of source indices into Table 16.	
28	Present Register Data	Present demand and values selected by Table 27	
29	(undefined)		

Decade 3

Table F.5 Decade 3 Local Display Tables

Table No.	Title	Description	Read / Write
30	Dimension Display Limiting	Maximum dimensional values for local display operation	
31	Actual Display	Actual dimensional values for local display operation	R
32	Display Source	Select source data for local display	R?
33	Primary Display List	Configuration of Primary display list (data, timing, scroll, etc.)	
34	Secondary Display List	Configuration of Secondary display list (data, timing, scroll, etc.)	
35	(undefined)		
36	(undefined)		

Table F.5 Decade 3 Local Display Tables

Table No.	Title	Description	Read / Write
37	(undefined)		
38	(undefined)		
39	(undefined)		

Decade 4

Table F.6 Decade 4 Security Tables

Table No.	Title	Description	Read / Write
40	Dimension Security Limiting	Maximum number of passwords and security access levels in end device	
41	Actual Security Limiting	Actual number of passwords and security access levels in end device	R
42	Security	Passwords; Read, Write, and Execute permission flags	R?
43	Default Access Control	Default table and procedure access permissions (for tables not included in Table 44)	R?
44	Access Control	Table and procedure access permissions for tables not using default access control	R?
45	Key	Authentication and / or encryption keys	R?
46	(undefined)		
47	(undefined)		
48	(undefined)		
48	(undefined)		

Decade 5

Table F.7 Decade 5 Time and TOU Tables

Table No.	Title	Description	Read / Write
50	Dimension Limiting Time and Time of Use	Maximum capabilities for Date & Time and TOU control	
51	Actual Time and TOU Limiting	Actual capabilities for Time & Date and TOU control	R
52	Clock	Real time clock	R
53	Time Offset	Time zone offset and DST information	R
54	Calendar	Schedule definition table for TOU	
55	Clock State	Real time clock information	R?
56	Time Remaining	Predictive time quantities	
57	(undefined)		
58	(undefined)		
59	(undefined)		

Decade 6

Table F.8 Decade 6 Load Profile Tables

Table No.	Title	Description	Read / Write
60	Dimension Limiting Load Profile	Maximum capabilities of Load Profile	
61	Actual Load Profile Limiting	Actual Load Profile capabilities	R
62	Load Profile Control	Data sources and formats used In Load Profile	R

Table F.8 Decade 6 Load Profile Tables

Table No.	Title	Description	Read / Write
63	Load Profile Status	Status of each Load Profile data set	R?
64	Load Profile Data Set 1	Load Profile data information, set 1	R
65	Load Profile Data Set 2	Load Profile data information, set 2	
66	Load Profile Data Set 3	Load Profile data information, set 3	
67	Load Profile Data Set 4	Load Profile data information, set 4	
68	(undefined)		
69	(undefined)		

Decade 7

Table F.9 Decade 7 History and Event Logs

Table No.	Title	Description	Read / Write
70	Limiting Log Dimensions	Maximum size and capabilities of History and Event Logs	
71	Actual Log Dimensions	Actual size and capabilities of History and Event Logs.	
72	Event Identification	Events supported by end device	
73	History Log Control	Defines History Log codes to be written to History Log.	
74	History Log Data	The History Log contents	

Table F.9 Decade 7 History and Event Logs

Table No.	Title	Description	Read / Write
75	Event Log Control	Defines Event Log codes to be written to the Event Log.	
76	Event Log Data	The Event Log contents	
77	(undefined)		
78	(undefined)		
79	(undefined)		

Decade 8

Table F.10 Decade 8 – User Defined Tables

Table No.	Title	Description	Read / Write
80	Dimension Function Limiting	Maximum values and control parameters for user-defined tables.	
81	Actual Function Limiting	Actual values and control parameters for user-defined tables.	
82	List	Data elements used in the generation of user defined tables.	
83	Selection	Selects data elements used in user-defined tables.	
84	First User Defined	User defined table 1	
85	Second User Defined	User defined table 2	
86	Third User Defined	User defined table 3	
87	Fourth User Defined	User defined table 4	
88	Fifth User Defined	User defined table 5	
89	Sixth User Defined	User defined table 6	

Decade 9

Table F.11 Decade 9 – Telephone Control

Table No.	Title	Description	Read / Write
90	Dimension Telephone Limiting	Maximum dimensions for telephone control data	
91	Actual Telephone Limiting	Actual dimensions for telephone control data	
92	Global Parameters	General parameters for call answer and originate	
93	Originate Communication Parameters	Call originate parameters	
94	Originate Schedule	Call out schedule	
95	Answer Communication Parameters	Call answer parameters	
96	Call Purpose	Reason for most recent call out	R
97	Call status	Progress of most recent calls to each phone number	
98	(undefined)		
99	(undefined)		

Appendix G. Glossary

Apparent Power	The product of the applied voltage and current in an ac circuit. Apparent power, or volt-amperes, is not the real power of the circuit because the power factor is not considered in the calculation. Ci20 calculates Apparent Power $= \sqrt{Watts^2 + VARS^2}$
ARO	At Rated Output
Average Power Factor	The ratio of kilowatt-hour pulses to computed equivalent kVAh pulses for the billing period.
Billing Period	The period of time (commonly a month) between readings of a meter, when those readings are used for billing a power customer. Also, the period of time between two consecutive demand resets.
Billing Period Reset	A task commonly associated with the Billing Read is the Billing Period Reset. The Reset causes a *snapshot* of register readings to be copied to storage as well as clearing Peak Demand readings and updating Cumulative and Continuous Cumulative readings. You must break a seal to perform a Billing Period Reset on the front panel. The Reset is recorded in the Billing Period Reset event buffer.
Billing Read	A Billing Read is the task of reading billing information from the meter front panel. If the billing information is required to be available to anyone, it can be programmed into the Normal display list (See *Casual* Read).
Burden	Load imposed by a device on an input circuit, expressed in ohms or VA.

Casual Read — A *casual* read is the ability to see measurements on a sealed, functioning meter without breaking a seal or otherwise violating the meter's security. The type and amount of information available during a casual read can be selected by the meter setup programmer using *JEMWare*.

Any non-secure readings can be placed in the Normal display list. If nothing is to be displayed to unauthorized users, the programmer can place the Blank or Segment Check display items in the Normal list. Consult the *JEMWare* user's manual for full configuration details.

Class; Class Amps — The maximum current for which a meter is specified to operate within its accuracy rating.

Coincident Demand Register — A *Coincident* register is one that the user can set to capture data at the same time as any Peak Demand Register. The Coincident register is linked to a Peak Demand register through *JEMWare* software. One or more registers can be set to "coincide" with a single Peak Demand register.

Cold Start — A procedure that returns the meter to factory default settings and *erase all stored data in the meter registers*. To perform a Cold Start in the Ci20 meter:

1. Remove power from the meter.
2. Simultaneously press the UP and DOWN arrow buttons while applying power to the meter, until the *Ci20* logo is displayed.

Continuous Cumulative Demand Register — A *Continuous Cumulative* register sums the selected quantity read at BPR plus the quantity from the Working register. The sum is continuously updated.

Cumulative Demand Register — A *Cumulative* register stores the selected quantity when a BPR occurs. The quantity in the register is saved until the next BPR command, at which time the quantity is added to the existing quantity. The sum accumulates until it is manually cleared.

Daily Schedule	The daily schedule is an array of times and rates, and it determines the moment at which a TOU period changes.
Demand	The average of some measurement over a defined period of time, traditionally calculated by accumulating the integrated measurement over the defined period (the *demand interval*) and dividing by the time.
Demand Deferral	A period immediately following a power outage during which demands are not calculated. It is determined by the number of demand-interval closures following the power outage.
Demand Prediction	An optional feature that calculates and displays the Demand value expected at the end of the present demand interval *before* the interval completes. This is used to monitor a load to prevent setting a new Peak Demand.
Demand Reset	A scheduled or user-initiated event that causes maximum demands to be zeroed and certain other calculations to occur.
DNP	Distributed Network Protocol: a serial communication protocol used in instrument networking.
Element	A voltage and current input pair to a meter or transducer, typically from the same phase. A half element takes advantage of mathematical relationships present in a three phase power system to eliminate the need for one voltage measurement.
Energy Constant	A number used to represent a fixed electrical quantity in the meter. Ci20 uses the following constants to report various energy quantities: • Km = Load Profile pulse weight • Ke = Energy Pulse weight, Secondary side • pKe = Energy Pulse weight, Primary side • Kt = Test Pulse weight • Kh = # Watthours per each rotation (of a mechanical disk meter); Kh is still used as a constant in digital meters.

Full Scale	A reference condition corresponding to the highest rated value of a given measurement. For watts, this condition occurs at the user's input voltage, class current rating, and unity power factor. For VARs, full scale is at the user's input voltage, class current, and zero power factor.
Health / Status Read	A Health and Status Read is concerned with evaluating the correct operation of the meter and its installation, not its billing data. Health and Status display items can be programmed into either Normal or Alternate display lists at the user's discretion.
Holiday	For TOU purposes, a holiday is a date contained in the holiday schedule.
Holiday Schedule	A holiday schedule is an array of dates (in seconds time format at midnight) within the TOU schedule that enables the meter to identify holidays.
Instantaneous Quantities	Instantaneous quantities are short-term average or RMS measurements of electrical characteristics in a circuit. Instantaneous quantities are suitable for developing Instantaneous Register, or Thermal Demand.
Integrated Quantities	Integrated quantities are power measurement quantities that are integrated over time, and which may be accumulated. Integrated quantities are used for developing Consumption, Fixed or Sliding Window Demand (Peak or Coincident), Load Profile, or pulse outputs.
Interval	A period over which a demand is calculated consisting of one or more subintervals.
IRLED	Infrared light-emitting diode, such as the optical port on the *Ci20* meter.
Ke, Kh, Km, Kt	See Energy Constant

KYZ	A meter output that indicates energy by toggling a Form-C contact output at a frequency proportional to power flow. Each transition represents some constant amount of energy (typically referred to as Ke, *energy constant*) that has been consumed. *Ci20* mimics this function by allowing the user to configure two solid-state contact outputs into a similar arrangement.
LLC	Line Loss Compensation: the ability of an instrument to measure or calculate the power lost in an imperfect conductor and to use that figure to modify its power or energy readings.
Leading Zero(es)	The main section of the meter's LCD readout can be configured (with *JEMWare*) to fill in unused display digits with either blanks or zeros. *Leading Zeroes* inserts *0* digits to the left of the most significant digit until all display positions are filled (there can be 6 or 8 digit positions, depending upon user-configuration).
Liquid Crystal Display (LCD)	Display area on the meter face that contains alpha-numeric characters for data readout.
Load Linearity	Specifies the maximum deviation of performance in percent registration over a range of current (load) assuming all other conditions at nominal reference conditions.
Load Profile	A record of energy consumption stored periodically (typically every 1 to 60 minutes) and sequentially. Each stored *interval* (one record) contains one or more *channels* (a single integrated quantity accumulated during the interval just ended).
(Load Profile) Periodic Special Event	The meter stores pulses accumulated since the time of the previous LP interval closure.
Load Profile Interval	An LP interval is the period between two consecutive LP interval closures.

Load Profile Record	An LP record is the data in a segment of load-profile memory where the accumulated pulses from a single LP interval are stored.
Loss Compensation	A generic term used to include both TLC and LLC.
Measurement Quantity	A single measurable characteristic of power flow in a circuit, or a commonly used combination of measurement quantities. E.g. Volts Phase A, Watthours Delivered Total.
MODBUS™	A standard serial communication protocol used by programmable controllers.
Null Modem	Cable that emulates a modem to enable the connection of two DTE (data terminal equipment) devices such as any two devices that would communicate with a modem (DCE) device.
Partial Load Profile Count	The total accumulated counts within an interval after the last special event or load- profile interval closure.
Past Interval Demand	The demand for the most recently ended demand interval.
Peak Demand	(a.k.a. Maximum Demand) The highest demand reading in a Billing Period.
Phase	The timing relationship between two signals of the same frequency, expressed as an angle. E.g. the delay between voltage and current waveforms in an AC circuit, or between voltage waveforms in different circuits. One of (usually) three circuits in a polyphase power distribution system. Each phase can be treated as an individual power source that is synchronized to the other phases in the system.
Polyphase	The sum, average, or combination (as appropriate) of measurements from all phases input to a meter.
Power Factor (PF)	The ratio of the real power (watts) to the apparent power (volt-amperes). PF is equal to the cosine of the phase angle between voltage and current.

Present TOU Period	The one Time Of Use period that the meter determines to be active at the present time. This is determined by the present date and time of the meter and the TOU schedule.
Preset Register Value	A numerical value other than zero or the standard default value, that can be saved on a PC for future use. Presets are typically used as a method of saving specific register settings from a removed meter for installation in a replacement meter. The preset file is saved using a .PRE suffix.
Pulse	A state change in either direction of a binary metering signal.
Register	Used to refer to specific quantities to be displayed or retrieved.
Register Assembly	The term used to refer to the hardware implementation of the display or control of the I/O functions of the meter.
Register Freeze	A command that can be issued by the user to move recorded data into storage registers for the purpose of downloading or retrieving the information at a certain instant. The meter continues to record data without interruption.
RMS	Root Mean Square: the equivalent DC value of a periodic (AC) signal. 5 amps RMS delivers the same amount of power to a given load as 5 amps DC.
Rolling Interval/Sliding Window	A demand measurement consisting of the summation of values calculated over multiple consecutive subintervals. A calculation is updated at the completion of each subinterval, but includes a defined number of previous subintervals.
Season	A season is a range of dates whose start date is contained in the season schedule in seconds time format.
Season Schedule	A season schedule is an array of dates within the TOU schedule that enables the meter to identify the seasons.

Seconds Time Format	A 32-bit number in units of seconds referenced from January 1, 1990.
Special Event	An event stored in load-profile data such as a register freeze, power fail, time set, etc.
Storage Register	A copy of a quantity which could be a displayable register and is saved when triggered by a demand reset.
Subinterval	The increment of time in which demand calculations are updated.
T_A	Test Amperes; equal to ½ Class Amps.
THD	Total Harmonic Distortion: a measure of the amount of harmonic content in a periodic signal, expressed as a percentage. A pure sine wave at the fundamental frequency has 0% THD.
Thermal Demand	A measurement filtered through a time delay such that step changes in the measurement are reflected slowly in the output. Commonly used to simulate the effects of current heating on power distribution equipment.
Thermal Time Characteristic	The time required for a Thermal Demand Register to reflect 90% of a step change in input. Similar to the time characteristic of mechanical thermal demand meters.
Threshold Alarms	*JEMWare* can be configured to monitor any Register and (if the proper option module is installed) generate a contact closure output based on the register's value. *JEMWare* compares the selected Register against the setpoints once per second. The user can configure these characteristics: • The register to compare against the thresholds • The upper threshold (set point) • The lower threshold (reset point) • Time • Time indicates hours, minutes, and seconds.
Time	Time indicates hours, minutes, and seconds.

TLC	Transformer Loss Compensation: the ability of an instrument to measure or calculate the power lost in an imperfect transformer and to use that figure to modify its power or energy readings.
Total Registers	Those *Ci20* registers that are not TOU registers are called total registers. The total registers always are active.
TOU Period	A selected duration of time during which the consumption, demand, and other information are assigned to a set of Time Of Use registers.
TOU Rate Indicator Output	A display segment that indicates the present TOU rate in effect.
TOU Register	A TOU register is a register of the *Ci20* meter that, for a designated TOU period, accumulates and may display amounts of electrical energy, demand, or other quantities measured or calculated.
TOU Schedule	The TOU schedule is a static, externally configured database within the meter. The data base contains information that allows the meter to determine the present TOU period based upon the real date and time of the meter.
VA	Volt Amperes or Volt Amps: the product of voltage and current in a circuit regardless of phase. Typically expressed in RMS units, this is also called *apparent* power. Ci20 calculates VA = $\sqrt{Watts^2 + VARS^2}$
VAh	VA hour: VA integrated over time to produce a measurement that may be accumulated.
VAR	Volt Amps Reactive: the product of voltage and current in a circuit, times the sine of the phase shift between the two. Typically expressed in RMS units. The unit of *reactive* or *imaginary* power.
VARh	VAR hour: VAR integrated over time to produce a measurement that may be accumulated.

W	Watt: the product of voltage and current in a circuit, times the cosine of the phase shift between the two. Typically expressed in RMS units. The unit of *real* power.
Wh	Watt hour: W integrated over time to produce a measurement that may be accumulated.

Appendix H. Factory Repair and Return

Factory Repair and Return

1. Obtain a Returned Material Authorization (RMA) number by calling the AMETEK Repair Department and giving the following information:
   - Model and Serial Number of the equipment.
   - Failure Symptom - **Be Specific**
   - Approximate date of installation.
   - The site name and address of the failed equipment.
   - Complete shipping information for the return of the equipment if other than the operating site.
   - Name and telephone number of person to contact if questions arise.
2. Enclose the information with the equipment and pack in a commercially accepted shipping container with sufficient packing material to insure that no shipping damage will occur. Mark the outside of the container with the RMA number.
3. Ship to the appropriate location:

Attention: Repair Department
AMETEK Power Instruments
255 North Union Street
Rochester, New York 14605 USA
Telephone: (585) 263-7700
Fax: (585) 262-4777

Your equipment is tested, repaired, and inspected at the factory. Normal factory turn-around is ten working days or less (excluding shipping time).

WARRANTY

AMETEK warrants equipment of its own manufacture to be free from defects in material and workmanship, under normal conditions of use and service. AMETEK will replace any component found to be defective, upon its return, transportation charges prepaid, within one year of its original purchase. AMETEK will extend the same warranty protection on accessories that is extended to AMETEK by the original manufacturer. AMETEK assumes no responsibility, expressed or implied, beyond its obligation to replace any component involved. Such warranty is in lieu of all other warranties expressed or implied.